DETERMINATION OF COWS' HOOVES HEALTH APPLYING THERMOGRAPHY

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Abstract. The aim of this study is to apply thermographic method for scanning high dairy yielding cows‘ hooves while keeping cows in the free-stall cowshed during the year, to create a thermographic map (model) of cows‘ healthy hooves under the positive and negative environmental temeperatures by applying FLIR system thermographic Therma CAM P640 camera, to diagnose functionional status of the cows‘ hooves (lameness), to perform an orthopaedic diagnosis and to identify pathological changes.

Different average temperatures ($P<0.001$) of hooves' skin surfaces in the areas of cows' front hooves *metacarpeus phalangia (mcp), interphalangia proximalis (mcip),* and *interphalangia distalis (mcid)* and hind hooves *metatarseus phalangia (mtp), interphalangia proximalis (mtip),* and *interphalangia distalis (mtid*) were diagnosed under the environment conditions. The temperature of the healthy front and hind hooves' surface of the skin was 15.49 ± 0.16 and 18.30 ± 0.40 °C, and the temperature of pathologically affected hooves was 23.24 ± 0.29 and 26.35 ± 0.16 °C, under the negative environment temperature. Under the conditions of positive ambient temperature, healthy cows' temperature of the front and back surface of the hooves' skin was 18.81 ± 0.09 and 20.17 ± 0.16 °C, and the temperature of cows with deteriorated condition of hooves was 26.52 ± 0.25 and 28.55 ± 0.10 °C. Temperature alterations of hooves were determined in 54.80 % of cows under the negative ambient temperature conditions and in 44.30 % of cows under the positive ambient temperature conditions.

The lameness was diagnosed by applying positive ambient temperature. In a herd insignificant lameness was established in 12.90 %, average degree of lameness in 62.90 %, significant lameness 33.87 % and very significant lameness in 6.45 % of cows. In case of lameness with locomotion score 3–5, the isotherm of the front hooves was from 7.08 to 7.35 ^{o}C and of the hind hooves from 7.65 to 7.85 ^{o}C higher in comparison with cows‘ healthy hooves.

During the orthopaedic analysis, there were established 12 different pathology types under the conditions of positive ambient temperature; the temperature of front and hind surfaces of hooves varied from 26.52 ± 0.25 to 28.55 ± 0.10 °C. In cases of pathologic alterations, the temperature of the surface of cows' front hooves was by 7.71 °C and hind hooves 8.38 °C higher than healthy cows‘ hooves.

It is expedient to use thermography for examination of cow's hooves health condition because in the early stage it is possible to diagnose the latent development of inflammatory processes and failure of the circulatory system, which are in good correlation with clinical signs.

Keywords: thermography, temperature, cow, hoof

Introduction

In experimental human and animal physiology thermal imaging will allow characterisation of the temperature of the surfaces of live subjects and the absolute values of these temperatures and their distributions may be related to underlying physiological, metabolic and behavioural processes and mechanisms (Mitchell, 2013). In relation to welfare evaluation, thermography measurements may be monitored on unrestrained animals which are free to perform their natural behaviours. The measurements, in conjunction with other scientifically assessed physiological and behavioural variables, may allow evaluating the organisms' negative stress reactions. Local or regional changes in blood flow resulting from vasomotor changes in response to physiological stimuli, pathology or environmental challenge may be characterised by means of thermography (Sagaidachnyi et al., 2012).

Lameness (or mobility) problems are widely recognized as a serious production and animal welfare issue in the dairy industry. Cows keeping free-stall systems are associated with higher rates of lameness (Cook and Nordlund, 2009). Cook (2003) found that lameness prevalence (during winter when the prevalence is highest) was 20 % in tie-stalls compared to 28 % in free-stalls. Haskell et al. (2006) reported lameness prevalence of 17 % in herds housed in free-stalls but allowed seasonal access to pasture compared to 39 % in herds housed strictly in free-stalls. Straw yards (Somers et al., 2003) and bedded backs (Barberg et al., 2007a, b) also tend to have lower rates of lameness. Within free-stall systems, lameness prevalence was 28 % in herds using non-sand stalls compared to 17 % in herds using sandstalls (Espejo et al., 2006). Furthermore, lameness was more prevalent when cows were exposed to concrete flooring (Somers et al., 2005; Vanegas et al., 2006). More specifically, lame cows recovered in a few weeks after allowed access to pasture (Hernandez-Mendo et al., 2007) and when the neckrail was removed from free-stalls (Bernardi et al., 2009).

Cook (2003) noticed that the prevalence of lameness was 28 % during the winter and 23 % during the summer among 15 free-stall herds in Wisconsin. Morever, among 25 % of high production cows housed in free-stalls in Minnesota, lameness ranged from 3 to 57 % across farms (Espejo et al., 2006).

Cramer et al. (2008) found that 47 % of cows in free-stall herds had lesions in at least one foot, and Bicalho et al. (2007a) found that 13 % of cows in a free-stall herd had a painful lesion (i.e. reaction to digital pressure applied to the lesion). Lameness was as high as 48 % among 33 free-stall herds in Germany (Dippel et al., 2009). Lameness is a significant economic problem as it results in reduced milk yield (Warnick et al., 2001; Green et al., 2002; Bicalho et al., 2008), reduced fertility, and increased risk of premature culling (Garbarino et al., 2004; Bicalho et al., 2007b). Lameness is often considered the biggest welfare concern for dairy cows due to pain associated with the injuries and its high prevalence (Whay et al., 2003).

Lameness indicates a problem that has deteriorated to the point where pain is felt and the cow consequently alters her gait or stance to cope. The cows hoof grows very similarly to the human finger or toe nail. Several factors affect the growth of the horn, such as diet, body condition, genetics, housing or grazing conditions, general wear and weight-bearing forces. This is evident in the rings that often occur on a cow's hooves, where due to variations in these factors, the horn is produced at different rates. Illness and disease in addition to environmental hazards can contribute to uneven horn growth or overloading of the claws and weight bearing on the heel area. Sole ulcers, white line disease and digital dermatitis are recognised as 'the big three' mobility conditions seen on dairy farms in the UK (Greenhough, 2007).

Hoof lesions appear to develop as a result of pathological changes to the internal structure of the claw (bone, fat pad and corium) and to the external protective claw horn capsule and skin epidermis. Hoof lesions may also occur due to factors which weaken the structure of the claw horn capsule and the integrity of the epidermis. Horn quality may be compromised from within by inadequate supply of macro- and micro-nutrients, such as zinc and biotin (Tomlinson et al., 2004), or by exposure to moisture (Borderas et al., 2004; van Amstel et al., 2004). The thickness and integrity of the protective horn layer of the sole and heel may be affected by excessively abrasive walking and standing surfaces (Shearer et al., 2006), or the action of infectious agents in unhygienic environments that compromise the epidermis and heel horn, weakening the structure of the claw (Berry, 2006). The role of heel horn erosion in claw horn lesion development is an intriguing area of research. Feeding of wet fermented diets appears to increase the prevalence of heel horn erosion before calving, due to increased exposure to wet slurry (Leach et al., 2005). Erosion of the heel may increase the susceptibility of the foot to claw horn lesion development post-partum providing a link between infectious and claw horn disease.

Lameness, as diagnosed by producers, is often underestimated (Whay et al., 2003; Espejo et al., 2006). Behavioural assessment, such as visual observations of cow gait, is usually the first line of lameness detection before hoof lesions can be identified during trimming (Bicalho et al., 2007a; Chapinal et al., 2009a, b). Gait scoring has been used to detect lameness by researchers (Cook, 2003; Espejo et al., 2006; Flower and Weary, 2006), but this method requires some training and some time to perform the assessments.

There is a lot of information in literature about cows‘ hooves thermogram peculiarities that are considered as traditional, conventional conditions. There is no information about hooves thermogram peculiarities in conditons when cows are kept in free-stall cowsheds, in shallow boxes, cold stalls, with no bedding, are loose during the year, and when dens are covered with rubber carpets.

It is commonly observed that cows with conditions of hooves have significant symptoms of lameness, reduced milk production feed intake and fodder eating, and digestive process disorder. During the preventive inspection of hooves and surgical hoof root removal control, high yielding cows‘ hooves deseases are often detected. However, significant inflammation symptoms often with extended collateral infection are very common then. Moreover, when cows are kept in a free-stall and are always in motion, hoof corneous tissue grows more centimetres per year than if they are kept in conventional way.

The aim of this study is to apply thermographic method for scanning high yielding cows‘ hooves, while keeping cows in the free-stall cowshed during the year. To create a thermographic map (model) of cows‘ healthy hooves under the positive and negative environment temperature by applying FLIR system thermographic ThermaCAM P640 camera. To diagnose functionional status of the cows‘ hooves, lameness, to perform an orthopaedic diagnosis and to identify pathological changes.

Materials and methods

The research was conducted on the population of Lithuanian black and white high yielding cows with 75 % and more of Holstein breed degree. They were kept in free-stall cowsheds, shallow boxes, cold stalls, with no bedding, loose during the year, and in dens covered with rubber mats. Cows (n=159) were from 2^{th} to 5^{th} lactations. During the research, the environment temperature in the cowshed was negative -1 ± 0.2 °C and relative humidity was 35 % whereas the environment temperature was positive $+18 \pm 1.2$ °C with relative humidity being 75 %. Cows were foddered by using mobile fodder divider, and were watered from the automatic water-trough. During the lactation, cows were milked twice (04:00 a.m. and 04:00 p.m, by means of a milking machine and fed twice daily (05:00 a.m. and 04:00 p.m.) during the experimental period.

ThermaCAM P640 ("FLIR Systems", USA) camera was used for cows' front and hind legs thermograms. The camera has diagonal of 142 mm LCD (1024 x 600 points) with extenal embeded liquid-crystal screen, thermal sensibility (NETD till 0.06°C at +30°C), type of detector FPA, non-freezing, 640 x 480 pixels, spectral range scanning fequency up to 50 Hz, sight angle 45 x 34 degrees.

The temperature of legs' skin surface was measured in the areas of front hooves - *metacarpeus phalangia (mcp), interphalangia proximalis (mcip),* and *interphalangia distalis (mcid)* and hind hooves *metatarseus phalangia (mtp), interphalangia proximalis (mtip),* and *interphalangia distalis (mtid*). Isotherms, i.e. middle lines, connecting *mcp* and *mcid* areas' points of the front hooves', and isotherms connecting *mtp* and *mtid* areas' points of the hind hooves' were measured and calculated.

The areas of the surfaces of the research were recorded and scanned by using thermal camera. The distance between the surface of the research and camera was 0.3–3 m. The visual thermo image evaluation was produced in real-time by using colour scale Rainbow HC. Thermograms and digital images were generated into the FLIR Tools system and computer analysis and evaluation were made. Thermogram images were evaluated by applying Lahiri (2012) method. Analysed body areas were compared with each other by applying asymmetric analysis, and measurements of different parts of the body were estimated by comparing them with healthy animals' models by using method of Ferreira and other scientists (2008).

There were examined 636 legs by applying thermographic method of cows' hooves temperature scanning, and there were made 3 spot measurements (n=2544) for each hoof's area together with isotherms evaluation.

In order to evaluate lameness, dairy cows (n=97) were examined individually, by applying Sprecher et al, (1997) method under positive environment temperature. After the milking, the standing posture of each cow and the walking process on the rubber mat and on the concrete paving path was studied. Scores were given according to the position of the back bend, steps even and posture symmetry while going, position of the hooves during the leg lifting and putting on the firm base and the angle of the leg position.

Orthopaedic research of dairy cows' (n=97) hooves was made after 24 hours under positive environment temperature, after the thermographic research and the evaluation of lameness. The following indications were registered during the research: front and hind hooves state and correct shape of the hoof. After that, each cow was examined individually. After the research area was drained, a detailed research of all areas of nails and hooves was made: each hooves' horn capsule was visually evaluated in the areas of hoof's wall, sole and back area of the hoof, and also conditon of the skin in between fingers, ridge area and area aroung the hoof. The sole sensibility research was made by using palpation pliers.

Statistical analysis was calculated by applying SPSS programme (license No 9900457**,** version 15, SPSS Inc., Chicago, IL). The results are considered as reliable under $P \leq 0.05$.

Results

After the analysis of the received thermograms, it was determined that under the negative environment temperature the average temperature of healthy cows' front hooves skin surface in *mcp, mcip,* and *mtid* areas was 15.49±0.16°C, and the average temperature of the hind hooves *mtp, mtip,* and *mtid* areas was 18.30±0.40°C, i.e. by 2.81°C higher ($P<0.001$) than that of the front hooves. The isotherm of the front hooves was lower by 2.47°C ($P<0.001$) than of the hind hooves' skin surface temperature (Table 1, Fig. 1).

Under the positive environment temperature, healthy cows' hooves skin surface average temperature of areas *mcp, mcip,*and *mtid* was 18.81±0.09°C, and of the hind hooves areas *mtp, mtip,* and *mtid* the average temperature was 20.17±0.16°C, i.e. higher by 1.36°C ($P<0.001$) than of the front hooves. The isotherm of the hind hooves was higher by 1.38°C ($P<0.001$) than of the front hooves' skin surface temperature (Table 1)

Table 1. **Skin temperature variation of front and hind legs of cows under the negative and positive environment temperature**

An area of test		Skin temperature, °C			
		Negative environment condition		Positive environment condition	
		Healthy legs (control), M±m	Legs with higher temperature, M±m	Healthy legs (control), M±m	Legs with higher temperature, M±m
Front leg	mcp	15.95±0.36	21.81±0.43	19.32±0.17	26.16±0.44
	mcip	15.49±0.31	23.25±0.51	18.77±0.21	26.45±0.52
	mtid	14.89±0.31	24.91±0.76	18.06±0.14	27.31±0.64
	isotherm	15.63±0.31	22.98±0.45	19.09±0.16	26.17±0.37
Hind leg	mtp	18.99±0.66	25.27±0.26	20.31±0.31	27.87±0.18
	mtip	18.04±0.79	26.13±0.32	20.30±0.32	28.44±0.20
	mtid	18.07±1.03	28.06±0.40	19.58±0.34	29.77±0.22
	isotherm	18.10±0.78	25.96±0.25	20.47±0.33	28.12±0.16

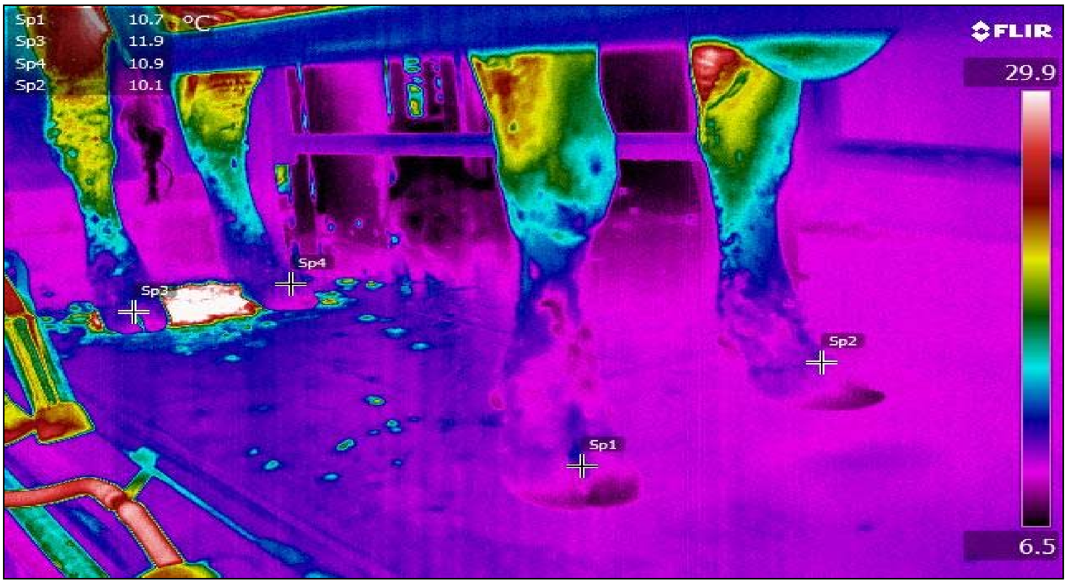

Fig. 1. **A normal thermal outcome in a sound claw.** This cow was showing locomotion score 1 (normal)

After 62 dairy cows were examined during the hooves scanning, the variation of the temperature of 46 front hooves and 90 hind hooves under the negative environment temperature was established. It accounted for 54.80 % of all examined hooves. Under the positive environment temperature, 97 cows were examined and variations of the temperature of 36 front and 136 hind hooves were established for comparison with healthy hooves model. It accounted for 44.30 % of all examined hooves.

After the examination of 97 cows‘ hooves, where lameness was valued, there was found 40.3 % of healthy cows (1 score), cows with insignificant lameness 12.90 % (score 2), cows with average degree of lameness 62.90 % (score 3), cows with significant lameness 33.87 % (score 4) and cows with very significant lameness 6.45 % (score 5) in the herd.

After the lameness evaluation scored 3–5, the isotherm from 7.08 to 7.35°C of the front hooves, and the hind hooves isotherm 7.65 to 7.85°C was established in comparison with healthy cows‘ hooves.

After the orthopaedic evaluation of all hooves of 97 cows‘, it was determined that 172 or 44.30 % of all hooves had different pathologies (Table 2). Twelve different pathological types were identified. All affected hooves made 197 pathological cases.

Results of the orthopaedic analysis, presented in Table 2, proved multitude pathological changes in the legs of cows, that were valuated by 2–5 scores of lameness, and had very high temperature from 26.52 ± 0.25 to 28.55 ± 0.10 °C (Fig. 2; Fig. 3) presented in the thermograms of the areas of measurements of front and hind hooves.

Among different orthopaedic cases of the front hooves and hind hooves, a strong positive temperature correlation ($r=0.728$; $P<0.01$) was found. Interdigital dermatitis (Fig. 2) was one of the most common single pathological changes that may occur in the front hooves. We found out that cows with pathological changes had their front hooves temperature of 7.71°C, or 41 % higher ($P<0.001$) than cows with healthy hooves.

Table 2. **Correlation of lameness level and diseases of hooves**

Lameness point	Leg	DD	ID	T	DS	SU	SH	WLD	SA	HE	B	OC	HA
1	Front	0	0	0	0	0	0	0	0	0	0	0	0
1	Hind	0	0	0	0	0	0	0	0	0	0	0	0
2	Front	0	0	0	0	0	0	0	0	0	0	0	2
2	Hind	0	0	0	0	1	0	0	0	0	0	7	1
3	Front	0	0	0	1	0	0	0	0	0	0	4	6
3	Hind	12	1	7	8	11	6	4	0	12	0	14	4
4	Front	2	3	0	3	8	0	0	0	1	0	2	4
4	Hind	8	5	7	5	8	4	5	0	8	3	1	0
5	Front	0	1	0	2	2	0	1	0	0	0	2	2
5	Hind	2	1	1	1	2	0	0	1	0	0	1	0

DD – Digital dermatitis, ID – Interdigital dermatitis, T – Tyloma, DS – Double sole, SU – Solar ulcer, SH – Solar hemorrage, WLD – White line disease, SA – Solar abscess, HE – Heell horn erosion, B – Bursitis, OC – Owergrow of corn, HA – Hooves abnormality.

Among different orthopaedic cases of the hind hooves and hooves without temperature changes, the average strenght of the positive temperature correlation (r=0.476; P<0.01) was established. Hind hooves surface temperature among different pathological cases and hooves without temperature changes were significantly different in all areas of measurement. We found out that cows with pathological changes had their hind hooves temperature of 8.38°C, or 41.6 % higher (P<0.001) than cows with healthy hooves. Multiple pathological cases (Fig. 3) are often identified in the hind hooves.

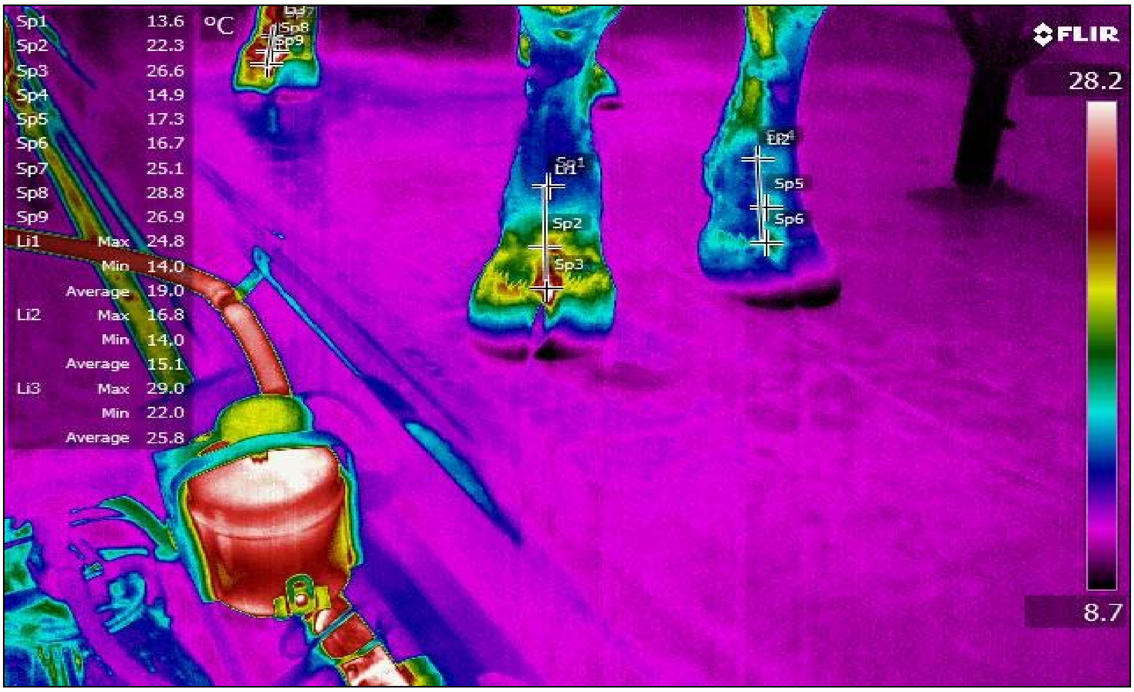

Fig. 2. **A lame cow** (locomotion score 3) **showing a warm area in the digital region.** Interdigital dermatitis disease was suspected.

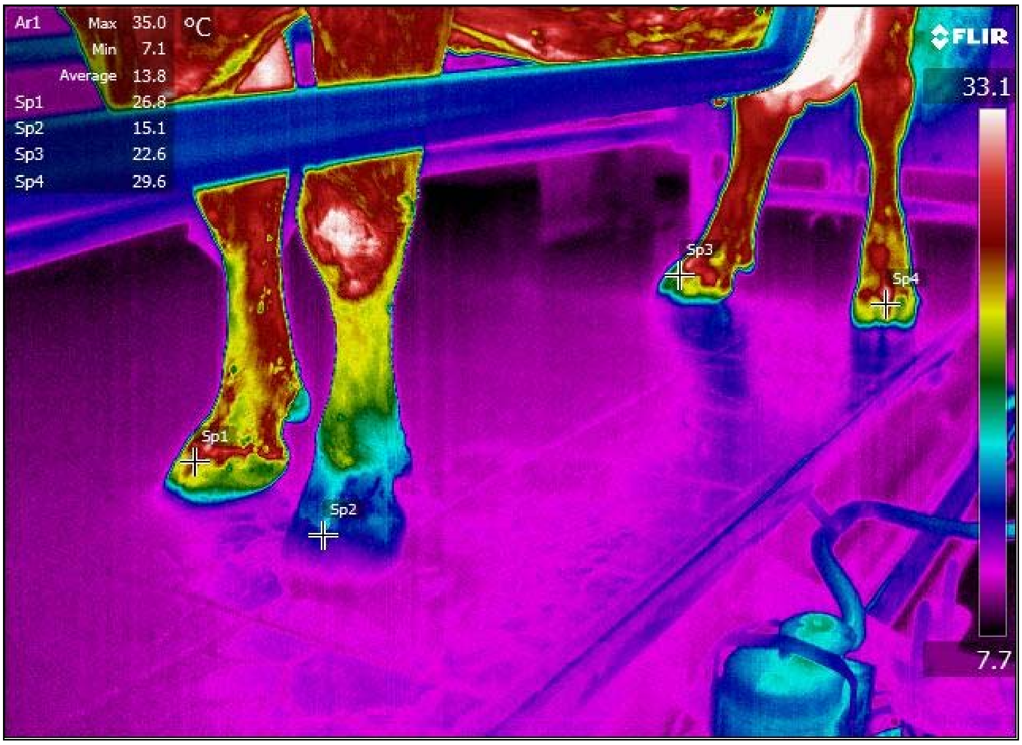

Fig. 3. **A lame cow** (locomotion 4**) showing a warm area in the digital region.** Didital dermatitis, Double sole, Solar ulcer, Solar hemorrage, Heell horn erosion, Owergrow of corn disease was suspected.

23.71 % of pathological changes of the front hooves and 87.63 % of the hind hooves were identified during the analysis of cows‘ hooves (Table 2). Digital dermatitis desease was diagnosed of the front hooves in 4.30 % and hind hooves in 14.10 % of cows, Interdigital dermatitis of the front hooves in 8.7 % and hind hooves in 4.10 % of cows. Tyloma, Solar hemorrage, Solar abscess and Bursitis cases were diagnosed only in the hind hooves and they accounted for 10 %, 7.10 %, and 1.80 %. Double sole cases in the front hooves accounted for 13 % and in the hind hooves for 8.20 %; SU was identified in the front hooves – 21.70 % and in the hind hooves 15.30 %. Front hooves made 2.20 % of White line disease, and Heell horn erosion cases, proportionally 5.90 % and 13.50 %. The biggest percentage of Hooves abnormality cases was diagnosed in the front hooves of 30.40 %, and hind – 3.50 %. Owergrow of corn cases were diagnosed in the front hooves – 17.40 % and hind – 14.70 %.

Discussion

Physiological state of the organism and also the temperature of different body parts are proportionally changing with the environment temperature. As environment temperature changes, the physiological state of the organism and temperature of different body parts also change. The skin and hypodermic bloodstream is fully expressed. The bloodstream intensity is the main determinal factor of the temperature of the skin. The temperature is higher above the large vein than beyond the tissue. Individual number of vessels, their position and features of the diameter, though often they are not significant in the diagnostics, may influence vessels‘ image changes. The average of the skin temperature of the body surface is homogeneous (the difference is not higher than 0.5–0.6°C). Physiological warmth asymmetry in the hooves varies from 0.3 to 0.8°C, and in the front stomach wall is not higher than 1°C (Tattersall, Cadena 2010). We diagnosed that under the negative environment temperature, the surface temperature of the healthy front hooves of the investigated areas‘ isotherms, that connect *mcp* and *mcid* measure places and pass through all 3 segments, was 15.63 ± 0.31 °C, and under the positive environment temperature - was 19.09 ± 0.16 °C. We correspondingly diagnosed 18.10 ± 0.78 °C and 20.47 ± 0.33 °C ($P<0.001$) of the hind hooves.

According to the received findings, we claim that the temperature of the isotherm of the front hooves surface, when pathological changes are diagnosed under the negative environment temperature, was 22.98 ± 0.45 °C and under the positive environment temperature 26.17 ± 0.37 °C ($P<0.001$). We correspondingly diagnosed 25.96 ± 0.25 °C and 28.12 ± 0.16 °C ($P<0.001$) of the hind hooves. These findings show that environmental conditions influence iradiated warmth of the healthy animal. Under the positivite environment temperature, the temperature of the front hooves was by 3.46°C and hind hooves by 2.37 °C higher than it was under the negative environment temperature. When pathological changes of the hooves were diagnosed, the temperature of the front hooves was by 3.19 °C and the hind hooves by 2.16 °C higher under the positive environment temperature.

Hooves‘ deseases are one of the most important unsolved problems in dairy industry in the world (Greenhough, 2007), and dairy cows‘ welfare, milk production and body weight are badly decreasing because of the hooves‘ deseases. Contagious (DD, ID) and mechanical (SU, WLD) claws‘ deseases are difficult to diagnose, and the healing and treatment procedures, until the final animal recovery, take very long time, even up to 5 months (Greenhough, 2007). Researches and received results maintained the conclusion about the relevant usage of thermograhpy, the recency of early hooves‘ inflammation diagnostics (Tarantino, 2013).

Lately, cow’s keeping technologies have been modernized in order to secure dairy cow’s health, longevity, and high quantitative and qualitative production index. Free-stalls and cold keeping models are applied more widely. Though, different paving mats are used, and cows get well-balanced ration, however, in the period of staying in stalls, cows often have diseases like laminitis, without clinical symptoms, they have claw’s pathology, and it is not always possible to diagnose the early disease symptom. If a cow has one of the claw’s diseases, one hoof gets the major part of the weight. If the hind leg is injured, the horn of the outer part of the hoof has development abnormality, and if it is the front leg – bigger physical weighting gets the other hoof. It is diagnosed that when cow’s pathological condition of the hind hooves is developing, then the outer part of the hoof becomes higher than the inner part, therefore, it gets bigger strain, ulcer is developing on the sole, and lameness symptoms are intense. The healthiest position for the ruminant is when the angle between the hoof and the paving or rubber mats is about 45 degrees. When the angle is bigger, the layer of the back side of the hoof becomes bigger. However, when the angle is smaller, the tip of the hoof may be very long. The most common hooves’ disease is dermatitis. The abnormal horn layer or cracks irritate and push the tender spot. Animals become lame because of the pain. The infection affects hoof’s sole and the horn layer of the wall, especially the hind hooves’ claw. The horn layer of the hoof’s sole stops growing and sags down and the ulcer forms. Because of this, the hoof deforms, cows put their legs very carefully and try to adapt to the position, however eventually these cows are prematurely condemned.

In order to control cow’s hooves areas during the year, it is recommended to use IRT as the permanent and long-term observation system. Rosina and others (2003) recommend applying this method periodically, i.e. to make the research with fixed intervals of time by qualifying efficiency treatment, or to follow thermal spread changes under the different environmental conditions, and time. We made the research periodically, with the break of 4 months. We recommended to make full analysis and to apply the appropriate treatment or preventive measures of cows with temperature changes in the areas of hooves.

This method is superior in comparison with diseases diagnostics during the claw clipping, as the condition of the cow's claws is evaluated without a contact with an animal, without stress, pain or without other forcible fixation tools help. The vet can evaluate healthiness from a distance of 0.3–3 metres, it is especially easy to do during the milking process, when each cow comes to the rotational milking stall. Technical conditions enable to install stationary IRT system, to install necessary parameters and to restore the database every day. The vet can evaluate recorded images of the cow's hooves every day. If the abnormal temperature is diagnosed, he can accomplish detailed clinical and orthopedic examination. The SU and WLD cases decreased after the following preventive implements were instituted in the milking farm, however, economic utility is obvious, as early diagnostics determined less treatment expenditure, faster healing, and by applying this preventive implement, milk yield did not decrease, as healthy cows, despite their constant examinations, were not stressed during the research (Tarantino, 2011). Other problems, for example, legs' or heels' abscess (SA) are often easily diagnosed by applying preventive claw clipping. New scientists' works (Zecconi et al., 2011; Sprecher et al., 1997) showed that IRT is the promising diagnostic tool in prevention of claws' pathologies.

Conclusion

1. In the areas of cows' front legs *metacarpo phalangia (mcp), interphalangia proximalis (mcip) and interphalangia distalis (mcid)* and hind leg areas *metatarso phalangia (mtp), interphalangia proximalis (mtip),* and *interphalangia distalis (mtid*), different hooves' skin surface temperatures (P<0.001) were diagnosed under the environment conditions.

1.1. The front and hind hooves' skin surface temperature of healthy cows was 15.49 ± 0.16 and 18.30 ± 0.40 °C, and in cows with hooves' deseases it was respectively 23.24 ± 0.29 and 26.35 ± 0.16 °C under the negative environment temperature.

1.2. The front and hind hooves' skin surface temperature of healthy cows was 18.81 ± 0.09 and 20.17 ± 0.16 °C, and in cows with hooves' deseases it was respectively 26.52 ± 0.25 and 28.55 ± 0.10 °C under the positive environment temperature.

2. Under the negative environment temperature 54.80 % of hooves with temperature variations, and under the positive environment temperature 44.30 % of hooves with temperature variations were diagnosed.

3. Insignificant lameness of 12.90 %, average degree of lameness of 62.90 %, significant lameness of 33.87 % and very significant lameness of 6.45 % of cows was established in the herd.

3.1. When lameness was scored 3–5 points, the isotherm of the front hooves was from 7.08 to 7.35°C, and the hind hooves isotherm from 7.65 to 7.85°C higher in comparison with healthy cow's hooves.

4. Twelve different pathological types were identified during the orthopaedic study, and the temperature of the surface of the front and hind hooves was from 26.52 ± 0.25 to 28.55 ± 0.10 °C.

5. In cases of pathological variations, the temperature of the surface of cows' front hooves was 7.71°C and of the hind hooves 8.38°C higher in comparison with healthy cows' hooves.

6. In order to diagnose increased skin surface infrared radiation, it is purposeful to use thermographic method which shows early development of inflammatory process.

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