Infrared Thermography use for Monitoring of Silage Matter Compaction

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Abstract: *This paper aims to monitor the compaction of silage matter by infrared thermography. The results obtained suggest that measurements by this modern diagnostic method can explain the heating of silage in different locations. High temperature has got effect at qualitative change of feed and its particular nutritional value.*

Keywords: *infrared thermography, corn silage*

INTRODUCTION

Widespread method used in diagnostics, research, development, monitoring and control of production processes is based on measure and display of thermal fields. Therefore, the development of thermal-vision techniques use increasingly sophisticated and precise measuring systems which are designed for thermal diagnostics area - special measuring of the surface temperature by a professional thermovision technique.

The basic conditions in livestock farming include, among animal health and housing technology also feeding for the entire complex. This includes the particular technique of feeding, use of appropriate feed and especially its quality. Volumetric feed constitute from 50 to 80 % of dry matter and its quality significantly contributes to the health and productivity of animals (Jech et al., 2011).

The main objective of the silage is the conservation and at the same time to maintain a relatively high humidity. Such modified crops are mainly used as a substitute for green food in the winter months, but also throughout the year. This is given by the condition of agricultural farm, which on includes soil and climatic conditions as well as altitude. If the dry matter content of silage increase from 20 % to 33%, the dry matter intake increase about to 2-3 kg per day. Calculated on energy value, this represents an increase of daily output by 3 to 6 litres of milk (http://www.agroporadenstvo.sk//).

Into the main terms of quality silage comes particular phase of plant vegetation, weather and harvest speed. Vegetation stage affects the presence of energy and nutrients for lactic fermentation. Silage is a source of nutrients, especially fibber, vitamins, organic acids and minerals. On the other hand, it can also be a source of dangerous and technologically undesirable microorganisms and factors, causing metabolic diseases of livestock. Therefore, this method of preservation deserves particularly close attention (Rada, 2009).

Rising temperature in the silage is a high risk of its deterioration. Heating of the sampling area is mainly the result of the ratio and the amount of acid produced during the fermentation. Important are preventive measures against this situation. Necessary is the strict technology discipline at the speed of loading, application of silage additives, and compaction of material, quick and perfect cover of silage. The silage should be opened on the leeward side.

By taking the silage out is the best to realize this by a specified technique (miller, silage cutters). After silage remove should remain in on the place a smooth wall. Inappropriate are different loaders, which unnecessarily disrupt the mass, thereby cause its aeration. Access of air immediately starts the secondary fermentation processes and the development of yeasts and molds (Honig, Weissbacg, 1999).

THE METHODOLOGY OF WORK

Measurements were taken in university holding Slovak Agricultural University, Ltd. Farm Oponice. The corn (hybrid KWS - KALIFFOFAO 440) with a solid content of

36 % has been stored in an above-ground silage channel and for its collection were used the cut pliers. The measuring of silage walls was done by infrared cameras ThermoPro TM TP8S IR Thermal Camera. Measured and evaluated were the following points:

- Top area after opening the foil (6 m high) before removing
- Sampling area (6 m high) before removing
- Sampling wall (height 1.5 m) before removing
- Sampling area (height 1.5 m) - 0.5 m depth after silage remove

Measurements were performed before the removal of matter (24 hours after the last cut-out, because at the farm is fed 1 x daily) and immediately after removal of feed (outdoor air temperature 2 ° C and relative humidity 55 %).

RESULTS

A) Top area after opening the foil (6 m high)

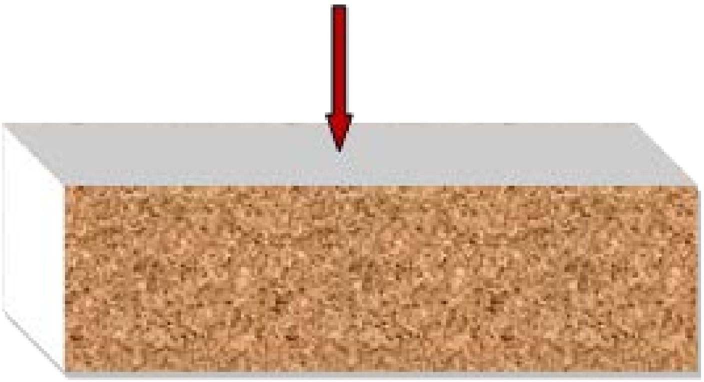

Fig. 1 Schema of measured area

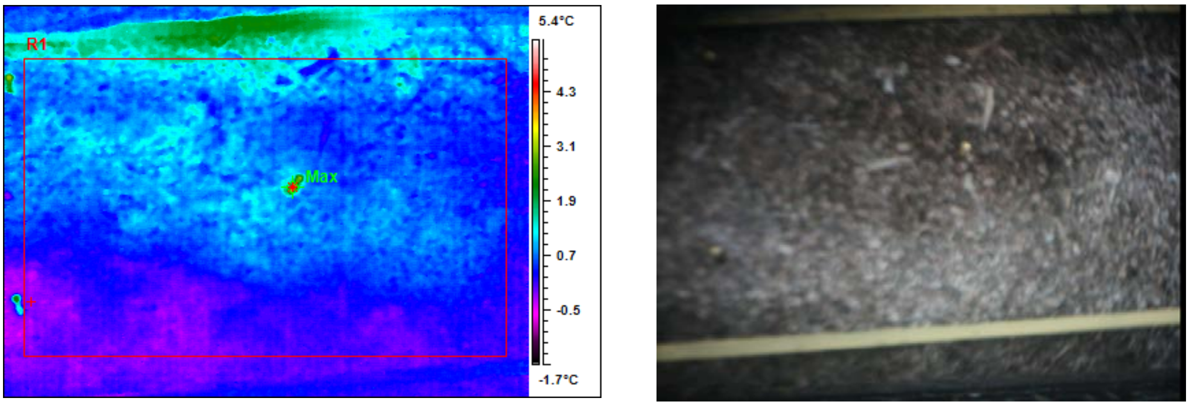

Fig.2 Left thermovision photo with scale, Right real photo

Tab. 1 Measured values

Object Parameter	**Value**
R1:AvgTemp	-0.6°C
R1:MaxTemp	5.1°C
R1:MinTemp	-2.4°C

From the measured results come out that the average temperature of the area before remove was - 0.6 ° C the minimum temperature -2.4 ° C and maximum temperature 5.1 ° C.

B) Top area before the opening (6 m high)

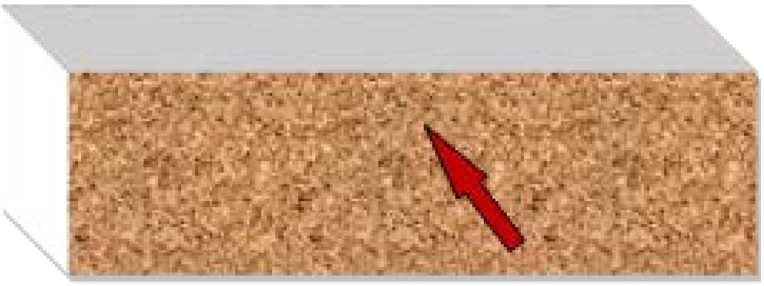

Fig. 3 Schema of measured area

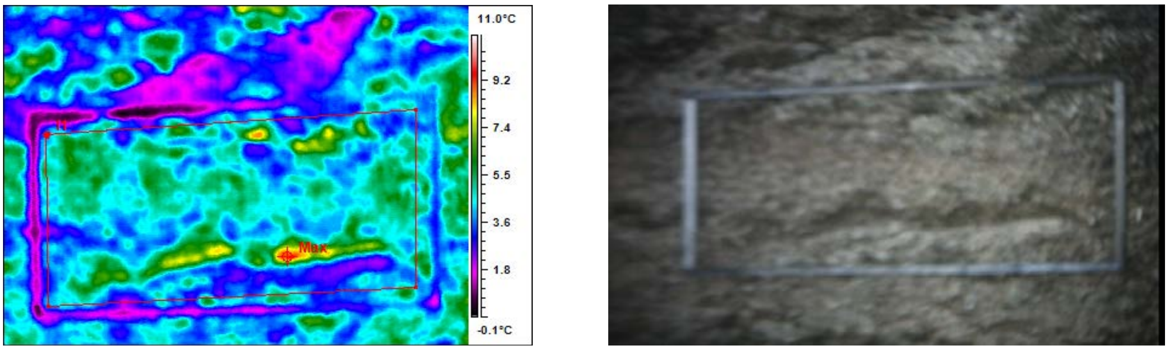

Fig. 4 Left thermovision photo with scale, Right real photo

Tab. 2 Measured values

Object Parameter	**Value**
R1:AvgTemp	3.6°C
R1:MaxTemp	6.2°C
R1:MinTemp	0,6°C

From the measured results come out that the average temperature of the area before remove was 3,6 ° C the minimum temperature 0,6 ° C and maximum temperature 6,2 ° C.

C) Top area before the cut-out opening (1,5m depth)

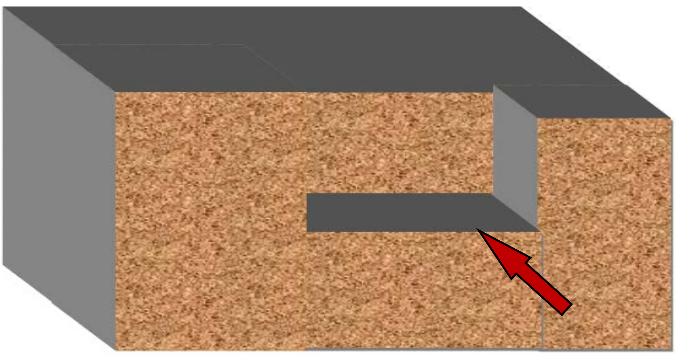

Fig.5 Schema of measured area

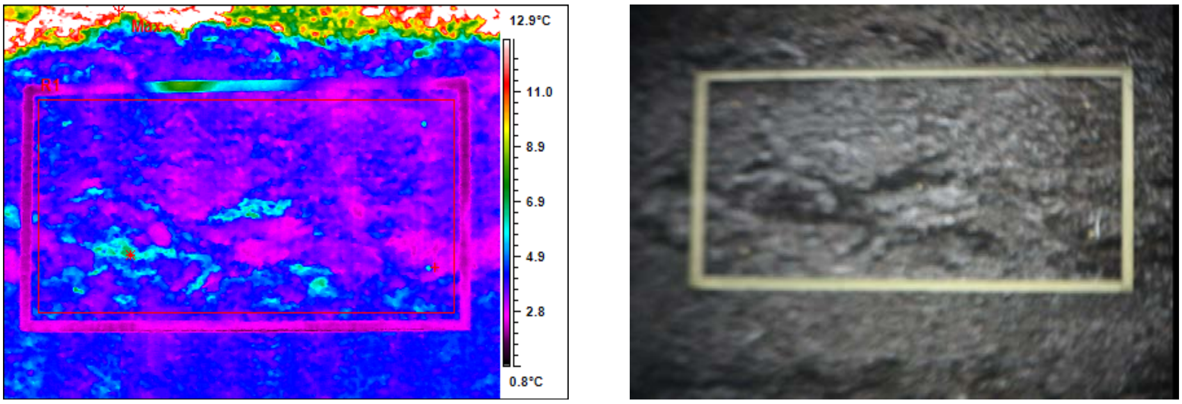

Fig. 6 Left thermovision photo with scale, Right real photo

Tab. 3 Measured values

Object Parameter	**Value**
R1:AvgTemp	2.6°C
R1:MaxTemp	8.1°C
R1:MinTemp	0.5°C

From the measured results come out that the average temperature of the area before remove was 2,6 ° C the minimum temperature 0,5 ° C and maximum temperature 8,1 ° C

D) Area after the cut-out opening (1,5m depth)

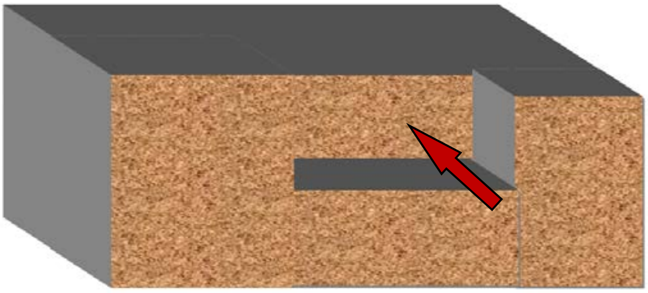

Fig.7 Schema of measured area

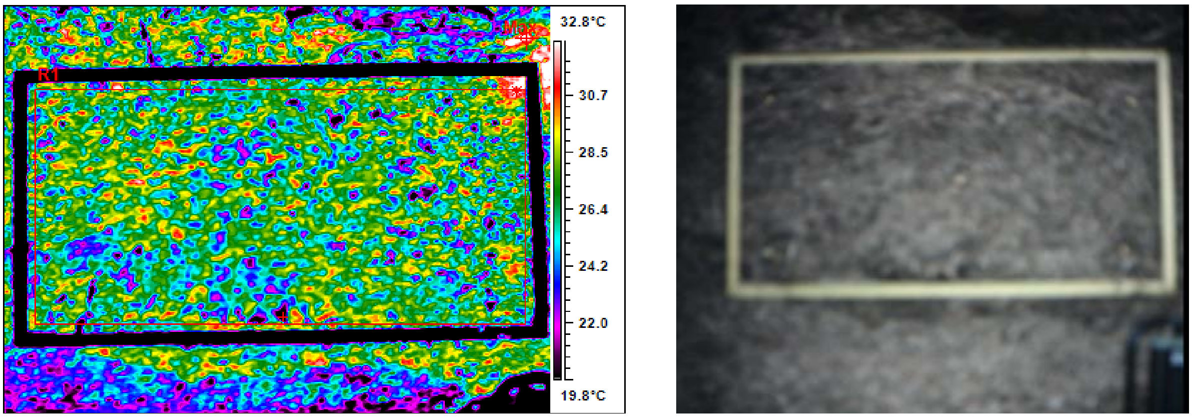

Fig.8 Left thermovision photo with scale, Right real photo

Tab. 4 Measured values

Object Parameter	Value
R1:AvgTemp	28.0°C
R1:MaxTemp	36.4°C
R1:MinTemp	13.0°C

From the measured results come out that the average temperature of the area after remove was 28 ° C the minimum temperature 13 ° C and maximum temperature 31,4 ° C

DISCUSSION

The work deals with the possibility of using modern diagnostic methods for the detection of silage heating mainly because of its lack of compaction.

Incorrect compacted silage is due the air susceptible to undesirable type of fermentation, lower aerobic stability, and to secondary fermentation (Rajčáková, Gallo, 2002). The average temperature of the measured area before the removal, depending on measured location ranged from -0.6 ° C to 3.6 ° C (at ambient temperatures 2 ° C). Low temperatures are due the fact that feeding takes place 1x per day so that the sampling area was exposed for 24 h low outside temperatures. After removal of silage, we found that the average temperature at a depth of 0.5 m was 28 ° C. At some point the measured surface temperature was up to 36.4 °C. This points to a lack of compaction (http://slovakia.pioneer.com), which is due to the development of the pathogenic micro flora of yeasts and molds. Temperature increase of 15 ° C corresponds to 1.5% of net energy loss per day (Winkelmann, http://www.schaumann.cz/ke-stazeni/produktove-letaky/prednaska-bioplyn-schaumann.pdf).

CONCLUSION

The results obtained suggest that the thermographic method is applicable for measuring temperature changes and to precisely identify the locations at which these changes are. This measurement can be performed quickly and without contact.

REFERENCES

[1] JECH ,J., et al., 2011. Stroje pre rastlinnú výrobu 3. 1.vyd. Praha: Profi Press 359 s. ISBN 978-80-86726-41-0.

[2] HONIG,H., WEISSBACH,F., 1999.Silážovanie, pomer medzi stratami sušiny a netto energiou [online]. [cit.2014-04-12]. Dostupné na: <http://www.cvzv.sk/pdf/Konzervacia-a-silazovanie-krmiv/Silazovanie-metodicka%20prirucka.pdf>

[3] KONONOFF, 2002. Forage and tmr particlesize and effects on rumen fermentation of dairy cattle [online]. [cit.2014-03-20]. Dostupnéna: <http://puyallup.wsu.edu/dairy/nutrientmanagement/data/publications/ParticleSizeFinal.pdf>

[4] RADA, V., Siláž, [online]. 2009., Výzkumný ústav živočišné výroby, v.v.i., Praha [cit. 2014-03-05]. Dostupné na :<http://www.vuzv.cz/sites/SilazRada.pdf>.

[5] RAJČÁKOVÁ, Ľ., GALLO, M., Konzervácia a silážovanie krmív, [online]. 2002., VÚŽV Nitra, Biofaktory, s.r.o., Bratislava [cit. 2014-03-05]. Dostupné na: <http://www.cvzv.sk/pdf/Konzervacia-a-silazovanie-krmiv/>.

[6] TŮMOVÁ, Z., 2014. Využitie termografickej metódy na odhaľovanie zahrievania siláže z dôvodu nedostatočného utlačenia. Diplomová práca. Nitra: SPU. 76 s.

[7] WINKELMANN, Příprava siláží z energetických rostlin pro bioplynové stanice, pro dosažení optimální produkce bioplynu [online]. [cit. 2014-07-04]. Dostupné na: <http://www.schaumann.cz/ke-stazeni/produktove-letaky/prednaska-bioplyn-schaumann.pdf>.

[8] http://www.agroporadenstvo.sk//
[9] http://slovakia.pioneer.com//

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