Ude, Gracia; Georg, Heiko and Schwalm, Anja

Study on injectable transponders with temperature sensor at bull-calves

Injectable transponders with temperature sensor function were applied subcutaneous to twelve Holstein bull calves at three different injection sites each. The injectable transponders were placed at the scutulum of the left ear, the ear base of the right ear and left side of the neck in the middle between poll and withers. The temperatures of the transponders were recorded using a hand held reader. The rectal temperature was measured simultaneously. After eleven months 33 of 36 injectable transponders were still functional. 90.8 % of the subcutaneous temperature values were lower than the rectal temperature.

Keywords
Organic farming, precision organic dairy farming, injectable transponders, body core temperature

Abstract
Landtechnik 65 (2010), no. 1, pp. 31-33, 4 tables, 1 figure, 5 references

Initial injectable transponders with temperature measuring option existed already in the mid eighties, in most cases 32 mm long. The bolus had additional functions at an early state as well, which could be easily implemented due to the size. A wide variety of sensor applications (pH-Sensor, temperature sensor, heart rate and measuring of ruminal contractions) are characteristic for the bolus at present. Growing herd sizes evoke the need for automatic measuring devices for individual physiological data as management tools for the future. In some cases a link between recording of physiological data and electronic animal identification could be easily conceivable.

Material and methods

The experiment had been realised at the FAL (Federal Agricultural Research Centre), predecessor institution of the Johann Heinrich von Thünen Institute (vTI), at the Institute of Production Engineering and Building Research as well as Agricultural Technology and Biosystems Engineering between March 2007 and February 2008. 12 German Holstein bull calves with an age of 2 up to 3 and three-quarter months at transponder application time were used in the experiment. The bull calves were slaughtered at an age of 13 and 15 months respectively.

The injectable transponders “Bio-Thermo®” were provided by Destron-Fearing. These transponders were relatively small (14.5 by 2.1 mm); common practice is to use them in pets and horses. The injectable transponders could either be implemented subcutaneously or intramuscularly. The electronic part is coated with a bio-compatible glass.

The “Bio-Thermo®”- chip provides a 15-digit individual code according ISO 11784 and has a temperature sensor. Data acquisition was done by using a handheld “Bio-Thermo®” reader (Destron Universal Pocket-Reader EX®). Rectal temperature was collected by utilising a veterinarian digital thermometer (VT 1831, microlife®) with a rapid acquisition time of 10 s. Three transponders were injected subcutaneously per bull calf: At the left ear under the scutulum (1), at the right ear base (2) and left part of the neck half between poll and withers (3). During four measuring periods with different climatic situations and at different times per day subcutaneous temperature was measured using the handheld reader whereas rectal temperature was acquired parallel using the thermometer. Every rectal and subcutaneous measure was repeated seven times. Measuring one calf took 2 up to 3 minutes. Two injectable transponders were evaluated in a water bath seven times and with 15 repetitions with the temperature ranging from 32 to 40 °C. Statistical analysis was done with the statistical package SAS 9.1. Standard deviations were calculated per single animal, location of measurement and time of measurement due to the individual characteristics of body core temperature. Subsequently, the mean values of the points of measurements were computed. The absolute temperature variations were calculated between rectal temperature and subcutaneous temperature referring to measuring period, animal, point of measurement and time of measurement.

Results

After injection of the transponders at March, 21st 2007 all injectable transponders were readable. Until the last measurement at February 19th 2008 10 (of 12) injectable transponders under the scutulum, 11 (of 12) at the ear base were functional and all 12 injectable transponders in the neck were still functional (**table 1**).

Regarding the injection sites low standard deviations could be observed for rectal values with 0.11 °C, neck and scutulum standard deviation was 0.15 °C and the value of the ear base injection site was 0.20 °C (**table 2**).

Lowest standard deviations were found in the water bath, ranging from 0.05 to 0.13 °C (**table 3**).

Finally 90.8 % of all subcutaneous body core temperature values were lower than the rectal temperature measured parallel. In detail 97.0 % of the values measured in the neck, 79.3 % of the scutulum values and 96.0 % of the ear base measures were lower than the corresponding rectal values. The mean variation between rectal and subcutaneous temperature under the scutulum was 0.49 °C whereas neck (0.96 °C) and ear base (1.27 °C) showed higher variations when compared to the rectal temperature (**table 4**).

As an example, mean values of one calf (ear tag 28999) are illustrated in **figure 1**. The data were collected at seven consecutive days between 7:30 and 8:30 h in the morning. Standard deviation ranged from 0 to 0.3 °C.

At all seven days of the measuring period the rectal temperature with values from 38.3 to 39.2 °C was higher than the subcutaneous temperature. Temperature values obtained from injectable transponders under the scutulum (37.5 to 38.4 °C) were higher than values measured at both other injection sites.

Table 1

Number of functional injectable transponders

Datum *Date*	**Anzahl Bullen** *Number of bull calves*	**Anzahl lesbare Injektate** *number of functional injectable transponders*		
		Dreiecks-knorpel *Scutulum*	**Ohrbasis** *Basis of the ear*	**Hals** *Cervical*
21.03.07	12	12	12	12
19.04.07	12	12	11	12
23.05.07	12	12	11	12
26.09.07	12	11	11	12
20.12.07	12	11	11	12
19.02.08	12	10	11	12

Table 2

Mean of standard deviations (C °) per point of measurement

Parameter *Parameter*	**Messort** *point of measurement*			
	Hals *Cervical*	**Dreiecks-knorpel** *Scutulum*	**Ohrbasis** *Basis of the ear*	**rektal** *Rectal*
Mittlere stdev (x) *mean of stdev (x)*	0.15	0.15	0.20	0.11

Table 3

Mean of standard deviations in water bath

Parameter *Parameter*	**Wdh. 1** *rep. 1 **	**Wdh. 2** *rep. 2*	**Wdh. 3** *rep. 3*	**Wdh. 4** *rep. 4*	**Wdh. 5** *rep. 5*	**Wdh. 6** *rep. 6*	**Wdh. 7** *rep. 7*
x [°C]	32.45	31.61	40.05	39.35	38.57	37.91	38.18
stdev(x) [°C]	0.06	0.05	0.07	0.08	0.08	0.13	0.07

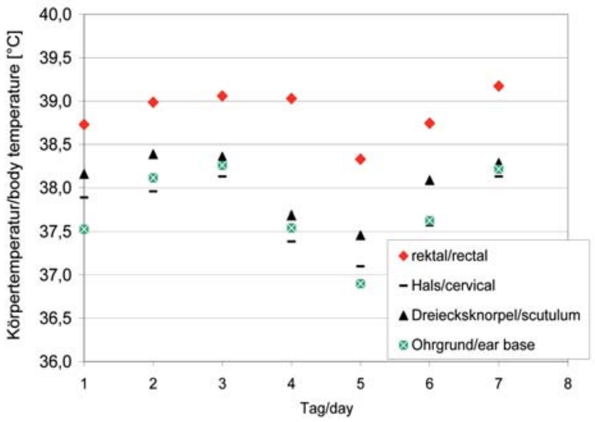
*rep.: repetition

Table 4

Mean of differences (C °) per calf and point of measurement

Parameter *Parameter*	**Rektal-Hals** *Rectal-cervical*	**Rektal-Dreiecksknorpel** *Rectal-scutulum*	**Rektal-Ohrbasis** *Rectal-basis of the ear*
Differenz *difference*	0.96	0.49	1.27

Fig. 1



Mean of rectal and subcutaneous temperature of one calf at seven consecutive days

Lowest values were achieved at the ear base (right ear) indicating 36.9 up to 38.3 °C. Regarding the graph of all measures (**figure 1**), measures of the three different injection sites and of the rectal temperature appeared to be parallel.

Discussion

The loss rate of injectable transponders with a size of 23 mm in an experiment with 18 145 cattle reported by [1] was lower than 0.3 %. According to [2] several injection sites and transponder sizes (28 by 3.6 mm) and (19 by 2.8 mm) were investigated. The read-failure rate varied between 19.4 and 9 % depending on the angle of injection at the ear base within 144 male and female cattle. Both injectable transponders were injected in 30 bulls. All injectable transponders were functional after 121 days. The housing system was the same for both variants.

In our own experiment injectable transponders were relatively small (14.5 mm by 2.1 mm) and thus provided a small target for damage. It can be assumed that broken injectable transponders were damaged by aggressive behaviour or by harsh contacts to the self-locking head gates. Transponders injected in the neck may be less sensitive to physical damage.

[3] used another system of measuring subcutaneous temperature, relatively large temperature transmitters with a size of 10 cm by 3.5 cm were implanted surgically in the abdominal cavity of 10 bulls. The body core temperatures showed low standard deviations between 0.21 and 0.29 °C due to a measuring point being within the body cavity and thus temperatures were closer to the body core temperature. In our own experiment standard deviations had to be calculated individually, cause the injection sites could not be standardised.

Within an experiment of [4] eleven injectable transponders were injected into silicon pads and calibrated in a water bath. 8 injectable transponders showed standard deviations between 0.3 and 1.7 °C, whereas 3 injectable transponders provided inaccurate values. The standard deviations of the injectable transponders in the water bath of our own experiment resulted in lower values between 0.05 and 0.13 °C. This raises the question of the influence of imbedding of injectable transponders in the tissue of animals or in this special case in silicon pads on the measuring accuracy of the injectable transponders.

In an investigation of [5] with 15 calves and subcutaneous injectable transponders under the scutulum the absolute variation between subcutaneous and rectal temperature was 1 °C in the average after the second experimental week.

In our own trial subcutaneous temperatures under the scutulum showed a lower variation of 0.49 °C compared to the rectal temperature. Our injectable transponders were obviously smaller than the ones used in the experiment of [5] with measures of 32 by 3.85 mm, may be this could be a reason for a bigger cooling effect.

Conclusions

Injectable transponders with temperature sensing option provide the facility for a telemetric measurement of the body core temperature. The variation of subcutaneous and rectal temperature was due to different injection sites.

The relatively high standard deviation of temperatures measured in the animal compared to the measurements in the water bath raises the question of the effect of encapsulation of transponders on temperature sensing as well as the influence of different types of the biological tissue like subcutaneous fatty tissue or cartilaginous tissue, on the temperature measuring function of injectable transponders. Further investigations should consider these aspects.

Literature

[1] Klindtworth, M., K. Klindtworth, G. Wendl und H. Pirkelmann: Die elektronische Tierkennzeichnung von Rindern im Praxistest – Ergebnisse zum EU-Forschungsprojekt „IDEA“ (Identification électronic des animaux). In: Wild, K., R. Müller und U. Birkner: Berichte der Gesellschaft für Informatik in der Land-, Forst- und Ernährungswirtschaft, Band 15, Referate der 23. GIL-Jahrestagung in Dresden, 2002, S. 124-127

[2] Fallon, R. J.; Rogers, P. A. M. and Earley, B.: Electronic animal Identification. End of project report. Beef production Series No. 46, 2002. http://www.teagasc.ie/research/reports/beef/4623/eopr-4623.asp; Zugriff am 9. November 2009

[3] Lefcourt, A. M. and Adams, W. R.: Radiotelemetry measurement of body temperatures of feedlot steers during summer. J. Anim. Sci. 74 (1996), no. 11, pp. 2633-2640

[4] Marsh, J. R.; Gates, R. S.; Day, G. B.; Aiken, G. E. and Wilkerson, E. G.: Assessment of an Injectable RFID Temperature Sensor for Indication of Horse Well-Being. In: ASABE: Livestock Environment VIII., 2008, August 31, 2008 – September 4, 2008, Brazil

[5] Kamann, B., K. Klindtworth, G. Wendl, W.-D. Kraetzl, H. Schön und J. Hartung: Automatische Gesundheitsüberwachung mit Hilfe von injizierbaren Temperaturtranspondern in der Kälberaufzucht. In: Construction, Engineering and Environment in Livestock Farming. Institut für Landtechnik der TU München-Weihenstephan, S. 249-254, 1999

Authors

Dr. agr. Gracia Ude, **Dr. agr. Heiko Georg** and **Dr. med. vet. Anja Schwalm** are research scietists at the Institute of Organic Farming (Head: **Prof. Dr. Gerold Rahmann**), Johann Heinrich von Thünen-Institut (vTI), Federal Research Institute for Rural Areas, Forestry and Fisheries, Trenthorst 32, 23847 Westerau, E-Mail: gracia.ude@vti.bund.de