Effects of sensor ear tags with twin pin fixing system on health and well-being of cattle

N. Gobbo Oliveira Erünlü[1], S. Rieder[2], T. Kuntzer[2], J. Bérard[1], O. Wellnitz[1]

[1]Agroscope, Animal Production Systems and Animal Health, Posieux, Switzerland;
[2]Identitas AG, Bern, Switzerland

https://doi.org/10.17236/sat00399

Eingereicht: 24.03.2023
Angenommen: 26.05.2023

Auswirkungen von Sensorohrmarken mit Doppelstift-Befestigungssystem auf die Gesundheit und das Wohlbefinden von Rindern

Eine Sensorohrmarke (SET) mit Global Positioning System (GPS), Beschleunigungsmesser, Radio-Frequency Identification (RFID) und Bluetooth-Technologie wurde auf Tragekomfort und Einhaltung von Tierwohl bei Rindern in der Schweiz im Freilaufstall und auf der Sommerweide getestet.

Die SET war mit einem Solarmodul und einem Akku ausgestattet und wurde mit einem «Twin Pin»-System befestigt. Zwölf neugeborene und 26 heranwachsende Tiere wurden im rechten Ohr mit den SET markiert. Während bei Neugeborenen gleichzeitig das linke Ohr mit offiziellen Ohrmarken versehen wurde, trugen die heranwachsenden Tiere bereits die offiziellen Ohrmarken. Die Neugeborenen blieben während des gesamten Experiments in einem Laufstall, während die heranwachsenden Tiere im Laufstall gehalten und im Sommer gealpt wurden.

Alle Tiere entwickelten ab Tag 7 nach der Markierung mit den SET Hautkrusten. In den ersten zwei Wochen wurden gelegentlich Schmerzreaktionen beobachtet. Das Wachstum von Ohren, markiert mit den SET oder der offizieller Ohrmarke, unterschied sich während der 11-monatigen Beobachtungszeit bei Neugeborenen nicht. Die Cortisolkonzentration im Speichel von Neugeborenen nahm in der ersten Woche nach der Markierung ab, was für diese Altersgruppe physiologisch ist. Bei älteren Tieren wurden die Cortisolkonzentrationen im Speichel nicht beeinflusst. Bei den SET wurden 19 Vorfälle bei 11 Tieren registriert, die ein Eingreifen des Tierarztes oder des Tierpflegepersonals erforderten. Zwei Tiere verloren die SET mit Ohrverletzungen. Bei allen Neugeborenen wurde in den Ohren nach neun Beobachtungsmonaten Narben aufgrund der Marken-Migration beobachtet.

Zusammenfassend wurde festgestellt, dass die SET, mit einem Gewicht von 32 g und einer Doppelstiftfixierung, im

Abstract

A sensor ear tag (SET) containing Global Positioning System (GPS), accelerometer, Radio-Frequency Identification (RFID), and Bluetooth technologies was tested for wearing comfort and compliance with animal welfare requirements in cattle in a free stall barn and on summer pasture in Switzerland.

The SET was equipped with a long-lasting battery via solar panel and used a «twin pin» fixing system. Right ears of 12 newborns and 26 adolescent animals were tagged with the SET. While left ears were tagged simultaneously with official ear tags in newborns, the adolescent animals already carried the official ear tags. The newborns stayed in a free stall barn during the entire experiment, while adolescent animals were housed in a free stall barn and on pasture during summer.

All animals developed crusts beginning on day 7 after tagging with the SET. Pain reactions were observed occasionally in the first two weeks. Ear growth in newborns during 11 months of observation did not differ between ears with SET and official ear tags. Cortisol concentration in saliva of newborns decreased in the first week after tagging which is physiological for this age group. In older animals cortisol concentrations in saliva were not affected. We registered 19 incidences in 11 animals with the SET, that required veterinary or staff intervention. Two animals lost the SET with ear injury. Scars due to tag migration were observed in ears of all newborns after the 9th month of observation.

In conclusion, SET with a weight of 32 g that need a twin pin fixation in cows do not seem to induce systemic or local inflammations more frequently compared to official ear tags; however, the higher risk of accidental injuries and migration in ear cartilage would not meet Swiss welfare standards and the attachment to the ear needs to be improved for general use.

Keywords: calves, cattle, GPS, sensor ear tag, legal animal identification, monitoring

Vergleich zu den offiziellen Schweizer Rindvieh-Ohrmarken nicht häufiger systemische oder lokale Entzündungen hervorrufen; allerdings entspricht das höhere Risiko von Verletzungen durch Unfälle und die Migration im Ohrknorpel nicht den Schweizer Tierschutzstandards. Die Befestigung am Ohr muss für den allgemeinen Gebrauch verbessert werden.

Schlüsselwörter: Kälber, Vieh, GPS, Sensorohrmarke, rechtsgültige Tieridentifizierung, Überwachung

Introduction

Livestock farming is subject to strict legal requirements to ensure animal welfare and the safety of food products of animal origin. In Switzerland, cloven-hoofed animals must be tagged within 20 days after birth with two ear tags according to the European Council Regulation and Swiss general provision to ensure uniform, clear, and permanent identification.[1,2,3] Furthermore, compliance with welfare regulations needs to be proven by livestock farmers, e.g. regular outdoor access for cattle must be evidenced by farmers by keeping a journal manually.[4]

Digital technologies are increasingly reaching livestock production to facilitate management and monitoring. Adding digital technologies to the identification procedure could lead to a series of synergistic gains. Electronic ear tags fitted with Radio-Frequency Identification (RFID)-transponders, supporting automated animal identification in husbandry systems, are commercially available and approved by the International Committee for Animal Recording (ICAR).[5] Furthermore, sensor ear tags (SET) equipped with active sensors achieve market maturity combining identification with other features like monitoring of movement data, from which behavioral patterns for the individual animal, but also on herd level can be deduced. However, such SET have not been evaluated in Switzerland so far. It is important that they ensure animal welfare.[6,7] Due to their functions SET are larger and heavier than approved tags. Ear tagging is slightly painful, and may induces cardinal signs of inflammation like redness, heat, swelling[8] which may lead to pain reflected by the animal's behavior.[9] Severe cases can trigger systemic reactions through immunological mediators such as defense reactions, to which the adrenal gland responds by increasing the production of cortisol.[10] Inflammation is a multifactorial process and is better approached using physiological markers and visual observation data simultaneously.[8,11] Minimal attention has been paid previously to the compatibility of ear tags of different size and weight, despite concerns regarding animal welfare.[12,13] However, for an introduction of new tags an investigation of compatibility is essential.

The aim of the present study was to evaluate a SET for its usability in terms of animal welfare under Swiss animal husbandry conditions in cattle of different age and under different housing conditions, including summering on alpine pasture. The tested SET was equipped with satellite communication (SATCOM), Bluetooth, and RFID. For long-lasting maintenance-free operation of these features a solar panel is required which results in a weight of 32 g with a double pin fixation to ensure its correct positioning. The RFID makes this sensor ear tag compliant with legal animal identification rules and regulations. Thus, this kind of SET seems to be particularly attractive for remote monitoring, because it has the potential to combine the legal identification of cloven-hoofed animals with data sensed from individuals and herds. Effects on animal health and welfare were investigated. The combination of different technologies in an ear tag could enable the automation of a series of mandatory notifications to authorities, among those the current journal for documentation of days out on an exercise area, and days out grazing for cattle.

Materials and Methods

In our experiment 38 SET equipped with SATCOM, accelerometer, temperature, Bluetooth and RFID technologies were tested for compatibility in female dairy cattle of different age. The experiment was conducted in compliance with the requirements of the Swiss animal protection and welfare law and were authorized by the Veterinary Office of the Canton of Fribourg (authorization no 2021-12-FR). A prototype SET which is not yet available for sale in Switzerland was used. The SET was equipped with a long-lasting battery via solar panel. Each ear tag consisted of two parts, weighing 32 g in total. The SET was 6,2 cm long, 3,54 cm wide and 1,35 cm thick. The solar panel was 4,77 cm long and 2,43 cm wide. The part fixed inside the ear was 5,60 cm long, 1,95 cm wide and 0,35 cm thick. The SET had two pins measuring 0,33 cm in diameter each. The distance between the two parts of the SET after locking was 1,45 cm. The SET was applied into the right auricle, whereas the official ear tag (OET) was carried in the left auricle of all animals. The OET also consisted of two parts, weighing 8 g in total. The OET was 8,43 cm long, 5,62 cm wide and 0,1 cm thick. The part fixed behind the ear was 6,80 cm long, 5,62 cm wide and 0,1 thick. The OET was equipped with a single pin polyurethane fixing system measuring

Figure 1: Picture of one representative newborn and one representative juvenile cattle wearing the sensor ear tag (SET).

0,67 cm in diameter. The distance between the two parts of the OET after fixing was approximately 1 cm.

Ear tagging

Twelve newborn calves aged 0 to 3 days (NB), 14 adolescent animals aged 7 to 11 months (AD1) and 12 pregnant adolescent animals aged 18 to 30 months (AD2) were tagged (figure 1).

The NB were tagged simultaneously with SET and OET. The AD1 and AD2 had the right ear tag removed and were then tagged with SET not using the existing hole. Ears and SET were disinfected with 70 % alcohol prior to tagging. Older animals were fixed in an examination stand. One person held the animal's head while another person tagged the animal using an applicator according to the manufacturer's instructions to ensure a correct position.

In order to follow the entire ear growth in NB, monitoring of calves was performed over a period of 11 months. For AD1 and AD2 the monitoring period comprised nine and

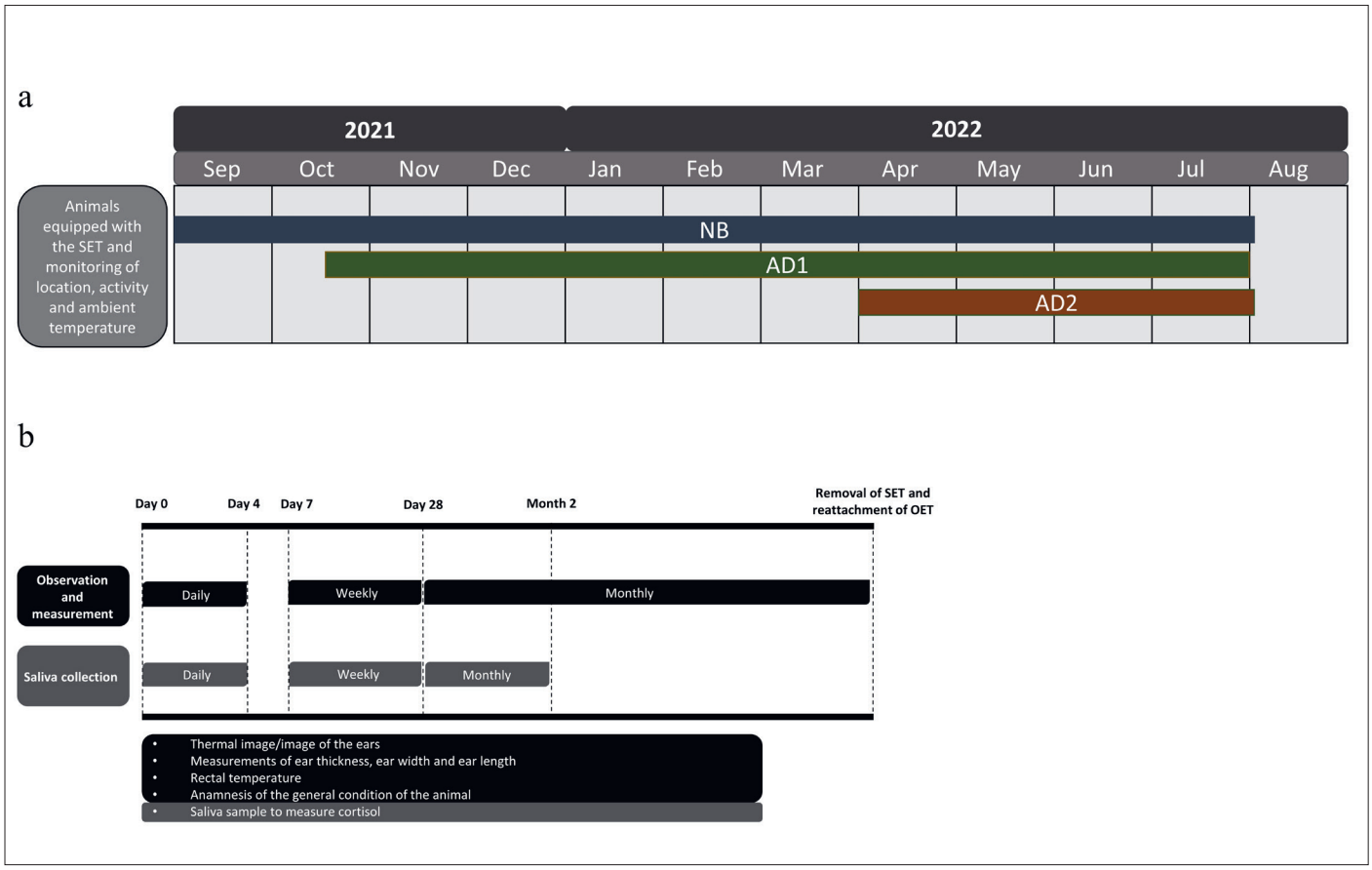


Figure 2: a) Timeline of the experimental period, indicating when the cattle were tagged with the sensor ear tag (SET) and when SET were removed. b) Diagram indicating the data collection and sampling schedule. (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months).

four months, respectively. AD2 monitoring mainly consisted of the summer pasturing period (figure 2a). After the experiment, all SET were removed and a OET was attached.

Observations and measurements

Ear thickness was measured with calliper (RISEMART, China), pictures of the ears were taken (iPhone 6, Apple®, California, USA) and the images were analyzed using Image J (ImageJ, Maryland, USA) to measure length and width. Ear temperature was measured with a SEEK thermal imaging camera (Reveal FirePro X, Seek Thermal, Inc., California, USA). Ear thickness, length, width, and temperature were measured in both ears. All observations and measurements according figure 2b. They were carried out by the same person during the entire period of the experiment to reduce variations and interferences.

Animal general condition and ear condition (alertness, head posture, BCS nutritional status, mucous membranes color and capillary refill time, skin turgor, ear tag attachment, crusts/exudate, redness, swelling, pain reaction, rectal temperature) were observed prior to tagging and continuously according to figure 2b. A defensive head movement when touching the ear was considered as pain reaction. Possible dry exudate on the surface of the skin, composed of serum, blood or pus, or a combination was classified as no crust, crust, and severe crust according to figure 3.

On day 21 of life, NB were dehorned using 0,3 ml Xylazin (Streuli, Uznach, Switzerland), 5 ml Lidocain 2 % per horn (Streuli, Uznach, Switzerland) and 1,5 ml Rimadyl (Zoetis, Delémont, Switzerland). Therefore, additional observations/measurements were performed on day 22.

Saliva samples

Saliva samples were taken immediately before tagging and then collected according to figure 2b. Salivette tubes (Sarstedt, Nuembrecht Gemany) were used by holding the associated sponge sideways into the mouth and letting the animals chew the sponge until it was wet. Then it was transferred into the collection tube. Tubes were kept on ice until the transport to the laboratory within 2h, centrifuged at 4°C, 3000 rpm for 20 minutes and stored at -80°C. Cortisol was measured in saliva samples using the Salimetrics Salivary Cortisol Enzyme Immunoassay Kit (State College, Pennsylvania, USA) according to the manufacturer's instructions.

Housing

The experiment was performed at the Agroscope research facility in Posieux and on the summer pastures at La Frêtaz and Le Chasseron in Switzerland. In Posieux animals were kept in free stalls with regular access to pasture. Animals kept on summer pasture remained on pasture exclusively. NB were housed in individual igloos with access to the outside and contact to calves housed beside until they were a maximum of one month old, then they were placed in a collective igloo with a total of 4 animals per igloo with access to the outside according to Swiss housing legislation. At the age of 3 months, all NB were brought into a free stall barn with regular access to an exercise area and nearby pasture.

AD1 and AD2 were housed in a free stall barn until end of May. Then they were transported to the summer pasture. AD1 were transported to the summer pasture at Le Chasseron and AD2 to La Frêtaz. Due to their pregnancy, AD2 were returned to the barn in Posieux according to their expected calving date.

Statistical analyses

All statistical analyses were performed using the software GraphPad Prism version 8.4.2 and are given at 95 % confidence intervals. Normal distribution of the variables was tested by Kolmogorov-Smirnov test. Data were analyzed with Unpaired t-test with Welch's correction to calculate significance. Chi-square test was used to analyze the pain

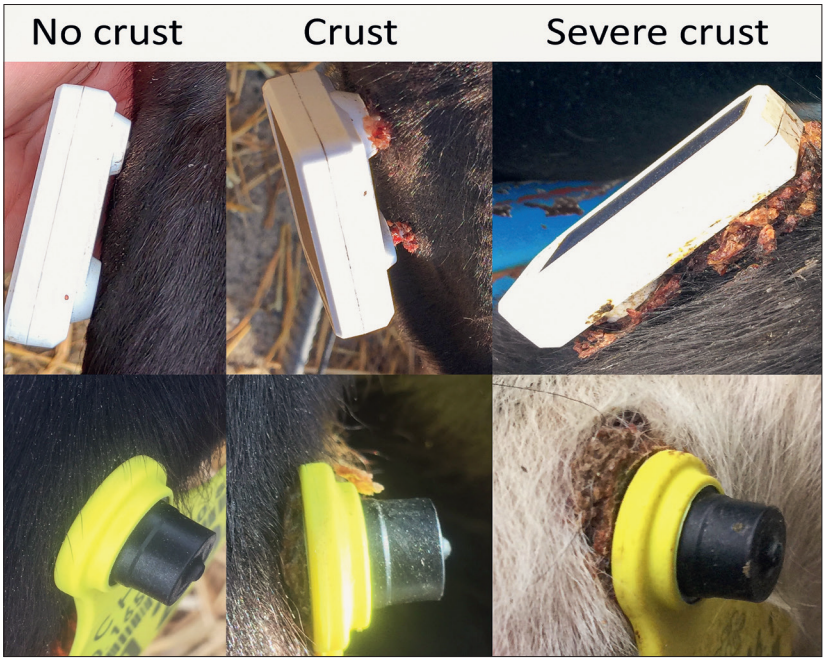


Figure 3: Classification of crust formation according to the scoring system in the ear of NB, AD1 and AD2 with the SET, and in the ear of NB with the OET. The classification ranged from no crust to severe crust (no crust = no blood or pus discharge, crust = crust presence, pus or blood discharge, severe crust = heavy discharge). (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months) (SET = sensor ear tag; OET = official ear tag).

reaction and crust presence. A value of $P < 0,05$ was considered statistically significant. Comparisons were made for the NB between SET and OET if applicable, between the NB, AD1, AD2 groups and their measurements on day 0, and between the groups. Incidents are described only.

Results

Ear measurements

NB, AD1, and AD2 did not show significant differences between length, width, and thickness of the left and right ears ($P > 0,05$). In comparison to day 0, ear width increased ($P < 0,05$) from month 2, length increased ($P < 0,05$) from month 5, and ear thickness increased ($P < 0,05$) from month 3 in NB with no differences between ears tagged with SET or OET ($P > 0,05$), respectively (figure 4).

No temperature difference was observed between the right ear with SET and the left ear with the OET in NB ($P > 0,05$). An increase in ear temperature was observed in ears of AD1 and AD2 tagged with SET in comparison to day 0 ($P < 0,05$). AD1 and AD2 tagged with OET presented an increase in ear temperature in month 7 and month 2 in comparison to day 0, respectively (figure 5).

Condition of animals and ears

Ear redness was observed in all animals (3 NB and 2 AD1 and 2 AD2) with an unpigmented and pale skin colour. In all animals with dark pigmented skin, redness could not be evaluated. Ear swelling was not observed. No alterations regarding alertness, head posture, BCS nutritional status, mucous membranes color and capillary refill time, or skin turgor were observed.

Pain reactions (shown in figure 6) were observed occasionally. The AD2 had the highest incidence of pain reactions. The total of pain reactions varied between NB, AD1 and AD2 ($P < 0,0001$); AD2 showed highest and AD1 lowest incidence of pain. No difference ($P > 0,05$) between the frequency of pain reaction of SET and OET was observed in NB.

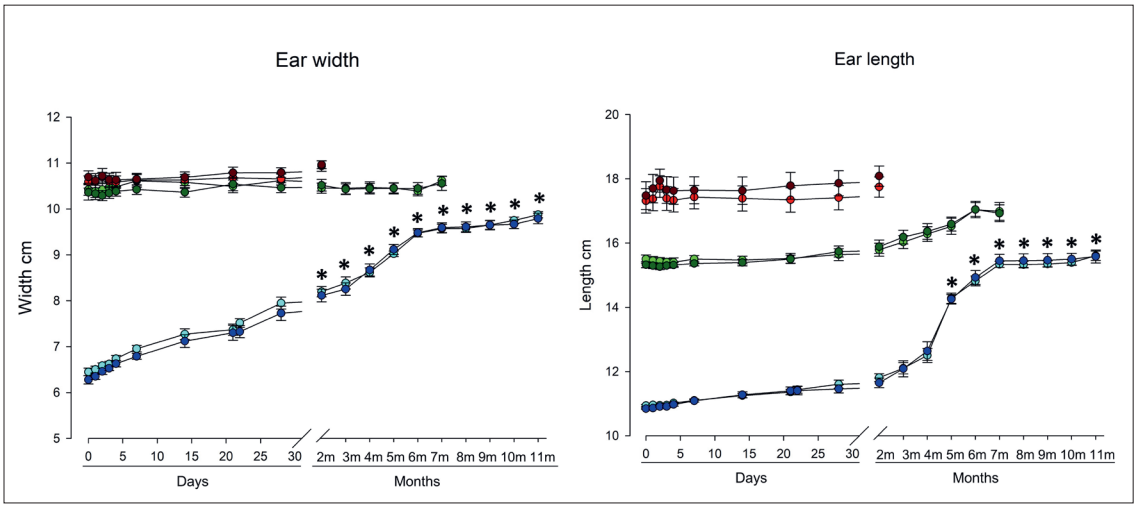


Figure 4: Ear length, width, and thickness (cm) measured in NB with SET (•) and OET (•), AD1 with SET (•) and OET (•), and AD2 with SET (•) and OET (•) during the observation period. The *indicates significant difference observed in NB compared to the measurements before tagging in both ears. Data are presented as means ± SEM. (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months) (SET = sensor ear tag; OET = official ear tag).

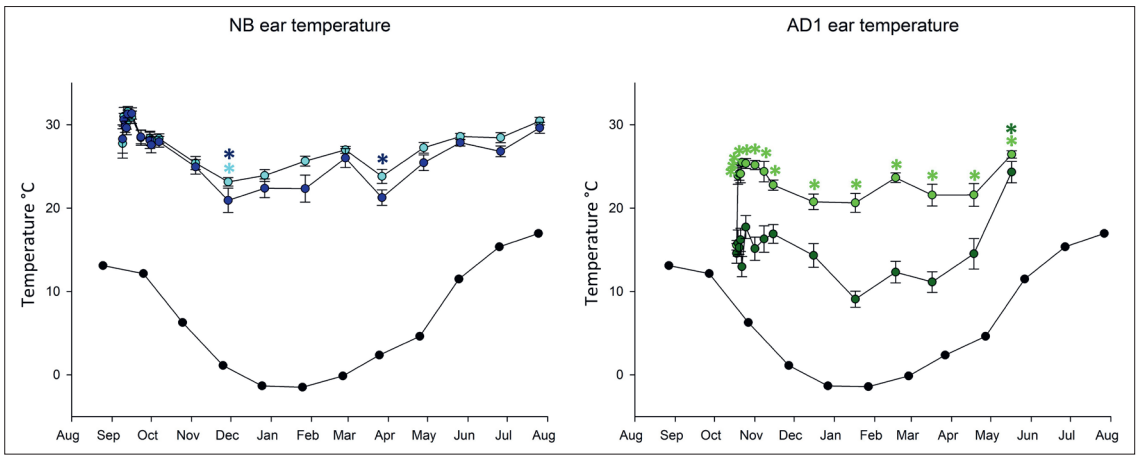
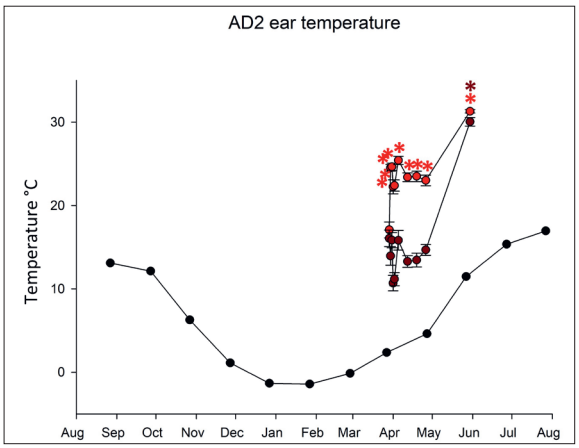


Figure 5: Measured temperature (°C) in the ears of NB with SET (•) and OET (•), AD1 with SET (•) and OET (•), and AD2 with SET (•) and OET (•) throughout the experiment. In addition, the average ambient temperature (•) of each month for entire Switzerland («Météosuisse»; https://www.meteoschweiz.admin.ch) is shown to better understand the temperature variation. *(SET in NB), *(OET in NB), *(SET in AD1), *(OET in AD1), *(SET in AD2) and *(OET in AD2) indicates the statistical significance compared to the baseline value measured on day 0, immediately before tagging. Data are presented as means ± SEM. (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months) (SET = sensor ear tag; OET = official ear tag).



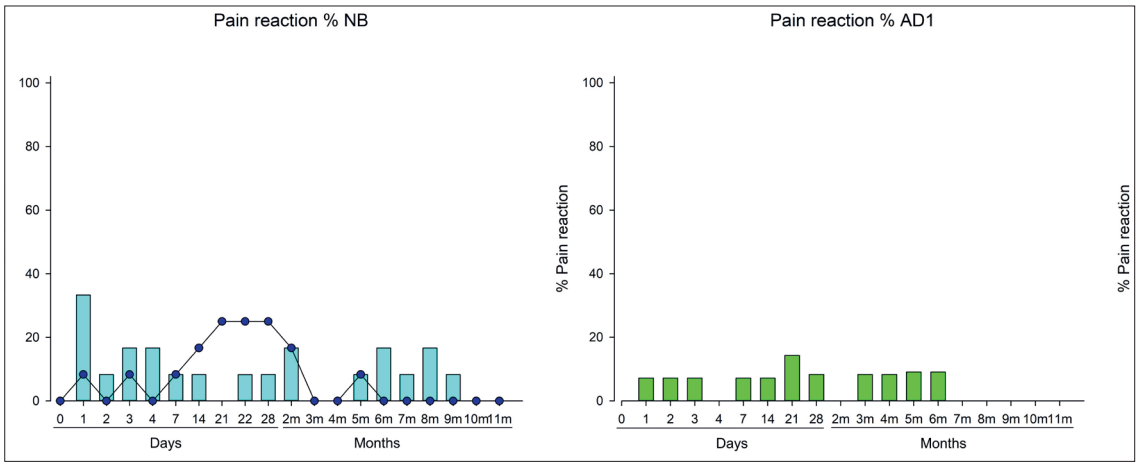
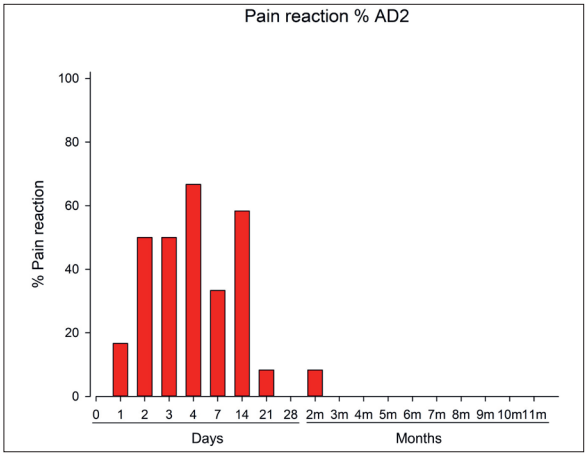


Figure 6: Prevalence (in %) of pain reaction in the ears of NB with SET (•) and OET (•), AD1 with SET (•), and AD2 with SET (•). Observations were classified in presence or absence of pain reaction. Only NB had the left ear simultaneously tagged with OET, for assessment of the presence or absence of pain with OET. (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months) (SET = sensor ear tag; OET = official ear tag).



Crusts occasionally appeared (figure 7). When present in NB, crusts were simultaneously observed on SET and OET during the first 3 months. All animals presented crusts beginning on day 7. There was a difference between the frequency of no crust, crust and severe crust between SET and OET in NB ($P < 0{,}0001$). The presence of crusts varied between NB, AD1 and AD2 ($P < 0{,}0001$) with SET; AD2 showed most severe crusts in the first two month.

No change of rectal temperature was observed within or between groups ($P > 0{,}05$).

All NB and one AD1 showed scars (figures 8 and 9) at the end of experiment when SET were removed. The medial hole had larger scars in comparison with the lateral hole ($P < 0{,}05$). No scars were observed in AD2.

Cortisol in saliva

Cortisol concentration in saliva (figure 10) of NB decreased in the first week after tagging. Before tagging NB showed higher ($P < 0{,}05$) saliva cortisol concentrations in comparison to AD1 and AD2. No variations in cortisol concentration were observed for AD1 and AD2 during the first two months of observation ($P > 0{,}05$).

Incidences

Some animals of all groups were observed to scratch their ears by rubbing against the ground and stall installations. Other behavioural changes related to the SET were not

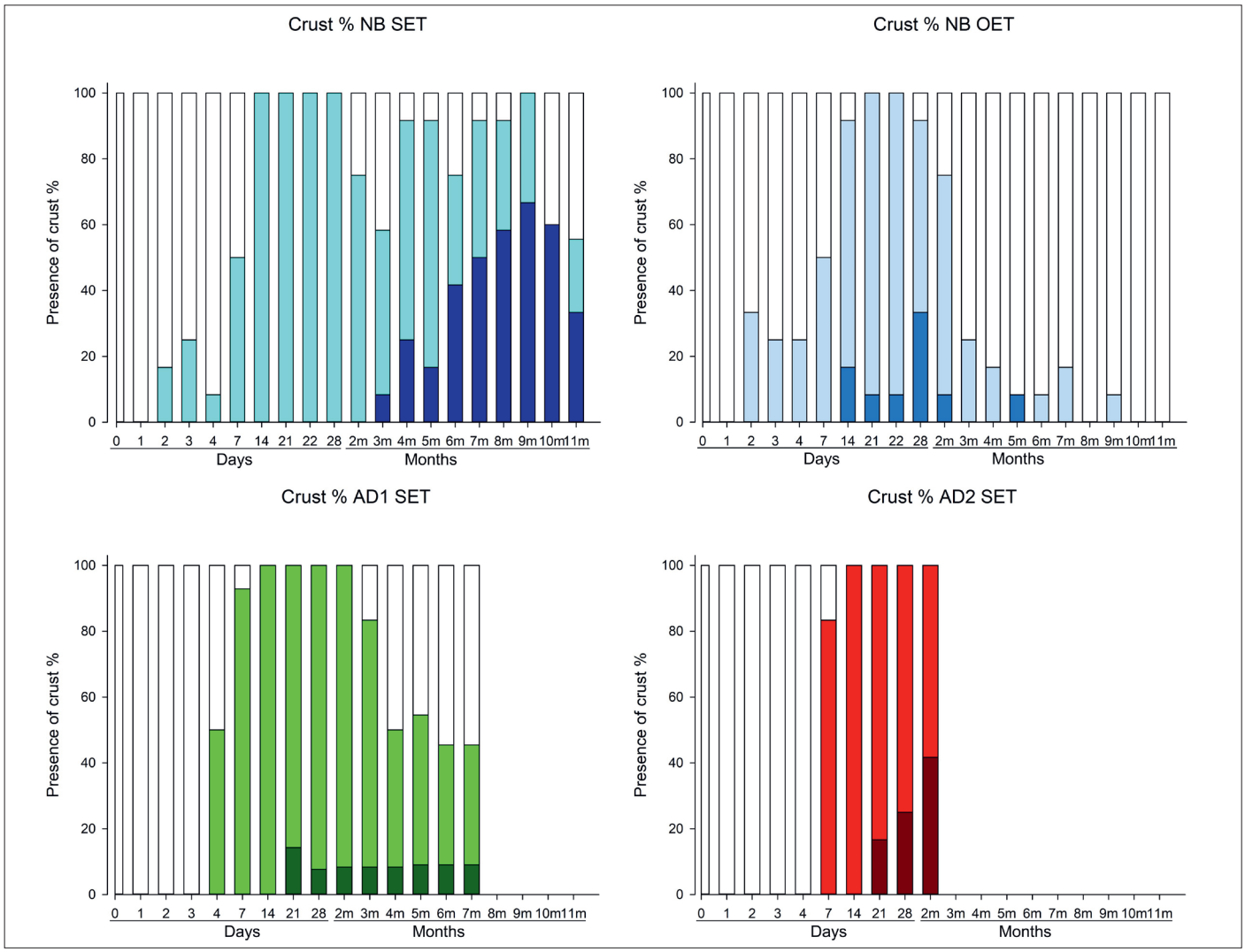


Figure 7: Prevalence (in %) of crust formation in NB with ears tagged with SET (• crust, • severe crust) and OET (• crust, •severe crust), AD1 with SET (• crust, • severe crust), and AD2 with SET (• crust, • severe crust). Only NB had the left ear simultaneously tagged with OET, for assessment of the formation of crusts with OET (no crust = no blood or pus discharge, crust = crust presence, pus or blood discharge, severe crust = heavy discharge). (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months) (SET = sensor ear tag; OET = official ear tag).

observed. Strong ear wagging was assigned to the presence of flies.

A total of 19 incidences in 11 animals required veterinary or staff intervention: three NB were trapped with SET between the stall bars; two AD1 had the SET torn off; 3 SET (one NB, one AD1 and one AD2) fell off the ear; four SET (three NB and one AD2) were unlocked on one side of the twin pin; two NB presented a severe infection which made it necessary to remove the SET; five SET (three NB, one AD1 and one AD2) were removed due to movement and causing scars. In total, 11 animals had to be excluded from the experiment ahead of the schedule due to incompatibility of the SET.

Discussion

The SET tested in this study communicates with satellites (SATCOM) which enables a precise location of animals obtained via global positioning system (GPS) which could determine whether an animal is in the pasture or barn area. This would make a handwritten journal redundant, thus facilitating the work of the farmers but also allowing for a better controlling. Furthermore, the SET is supposed to identify the animal for its entire life. However, because these SET are not approved yet for the use as official animal identificatory in Switzerland this study was essential to investigate the compatibility of the SET under Swiss cattle husbandry practices.

Although no literature is available regarding ear growth in calves, the twin pin and the form and weight of the SET did obviously not interfere with the ear growth in newborn calves as it was uniform and similar in both ears. The piercing of ears causes a wound, and wound healing involves a complex interaction between numerous cell types, mediators, and the vascular system.[8] Therefore, the increase in ear temperature after piercing in the present study was expected as a physiological response. In older animals an increased ear temperature was observed throughout the entire study indicating a delayed healing process. However, the ambient temperature is likely the reason for the simultaneous increase of ear temperature in the older animals in both ears in May. In addition, at this time many flies were present in the barn, and the animals were often seen to wag their ears, generating a greater blood circulation in the ear. However, no alterations regarding alertness, head posture, BCS, mucous membranes color and capillary refill time, skin turgor were observed indicating no effects on overall condition of the animals by the SET.

Pain is a factor that can be measured only indirectly in animals, e.g. by defence movements.[14] As the inflammatory phase of wound healing can take several days the highest incidence of pain reactions in the first two weeks after tagging was expected in all groups of the present study. Pain is the outcome of either initial damage or resulting from the inflammatory response itself. [8] The development of pain seems to be more pronounced when ear tags are placed in older animals.

The presence of crusts starting from day 7 in the ears after tagging with either SET or OET was due to the healing of the puncture site (see above). Wound healing initiates with the process of inflammation, bringing fluid with enzymes,

Figure 8: Representative example of the position of scars observed in ears of animals with SET. The orientation of the medial and lateral holes was taken into consideration in the classification of all scars observed in the NB and AD1. The NB in the picture had the SET for 9 months and 22 days before it was removed. (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months) (SET = sensor ear tag).

and AD2 are within the range observed in the literature. Earlier studies observed similar baseline values for saliva cortisol to those reported in this work, in a range from 0,32 µg/dl to 1,20 µg/dl (converted).[23] This indicated that the tagging and the wearing of a SET did not induce a relevant

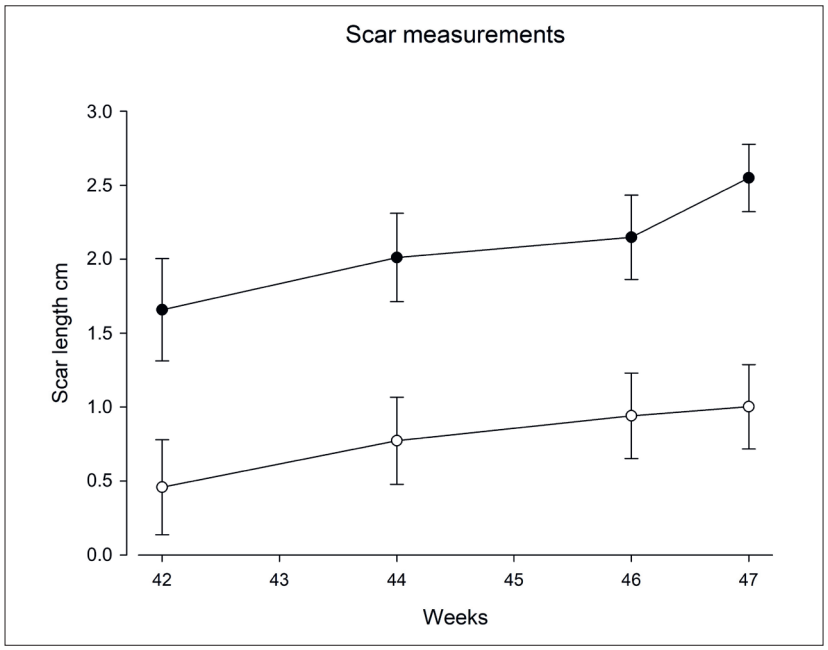


Figure 9: Measured length of medial (•) and lateral (o) hole scars observed in the ears of NB tagged with SET starting at month 9 of observation. Data are given in means ± SEM. (NB = newborn calves 0 – 3 days old) (SET = sensor ear tag).

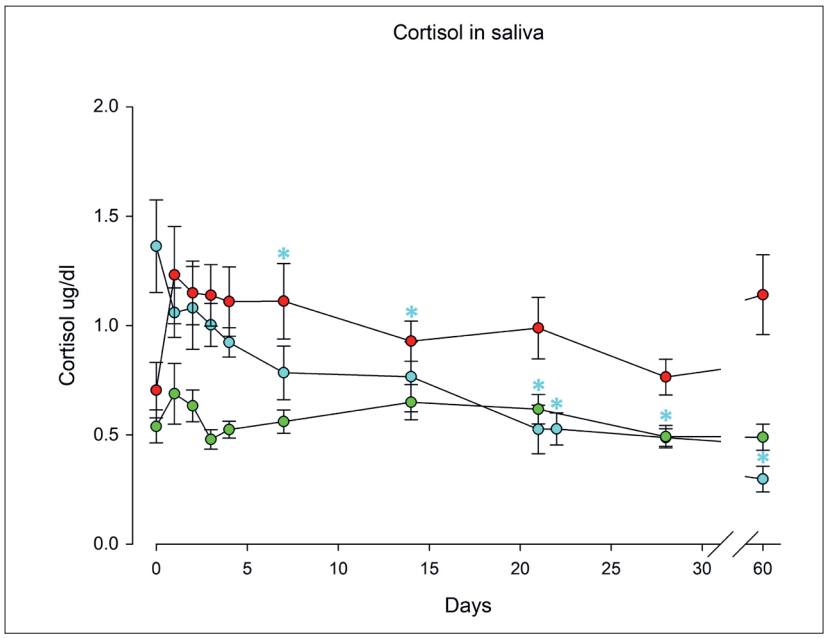


Figure 10: Mean values of cortisol concentration (µg/dl) in saliva samples from NB (•), AD1 (•) and AD2 (•) up to month 2. *indicates significant differences observed in NB compared to baseline values measured on day 0, immediately before tagging. Values on day 0 are used as control. Data are presented as means ± SEM. (NB = newborn calves 0 – 3 days old, AD1 = adolescent animals aged 7 – 11 months, AD2 = adolescent animals aged 18 – 30 months).

proteins and antibodies stimulating the wound repair.[15] Although a wound scab is formed to limit blood loss and close the wound, it has been indicated that preventing wound scab formation reduces the risk of contamination, healing more quickly, and scarring is also less frequent.[16] The equal formation of crusts in NB during the first few months regardless of ear tag type indicated that there was no difference in the initial healing. Two NB presented crusts or severe crusts at most of the experimental days. Simultaneously, the same animals had the largest scars observed among the NB indicating that the presence of crusts was related to possible scar formation and, therefore, migration of the SET. The variation in frequency and size of crust formation between the groups could be related to the age and development of the animals or to the duration an animal has worn the SET. The fact that NB wore the SET longer than AD1 and AD2 may be related to the frequency of new injuries, and consequently, the severity of scar formation.

We have observed cases in which the SET completely left its centralized position of the ear and migrated towards the edge of the ear. We have also observed SET that have left their original horizontal position and moved to a diagonally position. While polyurethane ear tags commonly used for the identification of cloven-hoofed animals in Switzerland since 1999 show low rates of damage to the ear on calves,[6,17] this movement resulting in scars has been attributed to the use of this type of ear tag.[18] Only one AD1 showed a scar, in the direction of the ear tip indicating rather an accidental occasion than a continuous migration, thus it was not possible to calculate the average of the measurements for the group. Interestingly, although the scars became evident after month 9, a concomitant increase in pain reactions was not observed during this period.

The use of SET and OET did not result in an increased rectal temperature, suggesting that the use of ear tags does not elicit a systemic immune response.[19] Cortisol is a physiological parameter frequently used to detect the activation of the innate immune system in response to stressors. It has been shown that cortisol can also be measured in saliva samples, reducing animal discomfort and ensuring that cortisol concentrations are not affected by sampling.[10, 20] Variations observed in cortisol concentrations in saliva in the present study seem to be related to the physiological adaptation of the NB to the new environment, having cortisol levels within the expected range for their age on day 0. The prolonged cortisol concentration during the first four days could be associated with frequent manipulation of the animals. Studies indicated that newborn calves appeared to adapt to the extrauterine environment gradually for 24 to 48 h after parturition.[21] Dystocia, exposure to environmental extremes and stressors can lead to inhibition of normal nursing behavior and prolonged elevations in serum cortisol levels. [22] However, cortisol concentrations observed in AD1

stress situation in all animals. On the other hand, ear scratching was observed in the ear with SET in our study which indicates discomfort. However, the animals showed no other behavioral changes related to the SET despite of ear wagging which could not be quantified and compared to cattle without SET and was attributed to the presence of flies. A German study evaluating sheep with different types of ear tag reported rubbing of the ear tag and scabbing only in few cases. The wounds of almost 3/4 of the sheep had healed four weeks after tagging.[18]

Previously it was described that ear tags with a longer spike led to a better healing, since it allowed better air access to the wound.[18] The SET used in the present study, showed in most of the animals little to no space on the medial pin side between the parts of the SET, inducing pressure on the ear, while the lateral pin presented enough space between the parts of the SET for the ear. This may have caused excessive movement of the used SET and lead to losses, accidents and injuries. In the United Kingdom, 18,1 % average annual losses of polyurethane plastic ear tags were observed in cattle,[24] while an average annual loss between 10 to 18 % was observed in Switzerland over the last five years.[25] Ear tags were correlated to 12 % of the suppurative injuries in sheep in Scotland.[26] A similar situation was reported by small ruminant farmers in Switzerland, participating in a survey on the effects of ear-tagging in sheep and goats during the 2019 - 2020 campaign for individual identification and registration of small ruminants. 1/3 of the respondents faced problems after re-tagging animals with the novel OET.[27] However, the size and shape of the evaluated SET was not compatible with stable structure in Switzerland, causing trapping of animals in feeding barriers.

Conclusion

Sensor ear tags (SET) with a power supply via a solar which are intended to comply with lifelong legal animal identification have been tested in this study. The SET need a twin pin fixation due to their weight (32 g vs. 8 g of the official ear tag OET). This seemed not to induce systemic or local inflammations in newborn calves more frequently than the OET or in adolescent animals. However, the SET had a high risk of causing accidental injuries, infections, and migration of the tag in the ear, in animal housing systems commonly used in Switzerland. The frequent injuries and the scarring observed during the study period suggest, that these ear tags do not meet the animal welfare standards in Switzerland in its present form. From the technical point of view, the SET is useful for autonomous monitoring of cattle.[28] Regarding animal welfare the SET needs to be improved before it can be considered for legal animal identification purpose in the production system in Switzerland.

Acknowledgments

This study was supported by the Federal Office for Agriculture (ARAMIS project number 21.16).

We thank the staff of the Swiss Federal Research Station Agroscope in Posieux, especially Lukas Eggerschwiler, Ives Joye, and Amélie Liaudat for excellent support during this experiment. Furthermore, we would like to thank Kosuke Ueda and Ulla Heikkilä from Identitas AG for their helpful hints to the manuscript.

Effets des marques auriculaires à capteur avec système de fixation à deux tiges sur la santé et le bien-être des bovins

Une marque auriculaire à capteur (SET) contenant les technologies Global Positioning System (GPS), accéléromètre, identification par radiofréquence (RFID) et Bluetooth a été testée en termes de confort et de conformité aux exigences de bien-être animal chez des bovins dans une étable à stabulation libre et sur des pâturages d'estivage en Suisse.

Le SET était équipé d'une batterie longue durée via un panneau solaire et utilisait un système de fixation «twin pin». Les oreilles droites de 12 veaux et de 26 génisses ont été équipées avec le SET. Les oreilles gauches ont été marquées en même temps avec les marques officielles chez les nouveau-nés alors que les génisses portaient déjà ces marques officielles. Les nouveau-nés ont été détenu dans une étable

Impatto dei marchi auricolari a sensore con sistema di fissaggio a doppio perno sulla salute e sul benessere dei bovini

Un marchio auricolare con sensore (SET) contenente le tecnologie GPS (Global Positioning System), accelerometro, RFID (Radio-Frequency Identification) e Bluetooth è stato testato per verificarne il comfort e la conformità ai requisiti di benessere animale nei bovini in una e su un pascolo estivo in Svizzera.

Il SET è stato dotato di una batteria a lunga durata tramite pannello solare e ha utilizzato un sistema di fissaggio a «doppio perno». L'orecchio destro di 12 vitelle e 26 manze è stato marcato con il SET. Allo stesso tempo, le orecchie sinistre dei vitelle sono state marcate con le marche auricolari ufficiali, mentre gli manze adolescenti le portavano già. I vitelle sono rimasti in una stalla a stabulazione libera per

Effects of sensor ear tags with twin pin fixing system on health and well-being of cattle

N. Gobbo Oliveira Erünlü, S. Rieder, T. Kuntzer, J. Bérard, O. Wellnitz

à stabulation libre, avec accès à une aire de sortie et aux paturages voisins pendant toute la durée de l'expérience tandis que les génisses ont été logés dans une étable à stabulation libre et en pâturage pendant l'été.

Tous les animaux ont développé des croûtes à partir du 7e jour après le marquage avec le SET. Des réactions douloureuses ont occasionnellement été observées au cours des deux premières semaines. La croissance des oreilles des nouveau-nés au cours des 11 mois d'observation n'a pas différé entre les oreilles marquées par le SET et les oreilles marquées de manière standard. La concentration de cortisol dans la salive des nouveau-nés a diminué au cours de la première semaine successive au marquage, ce qui est physiologique pour ce groupe d'âge. Chez les animaux plus âgés, les concentrations de cortisol dans la salive n'ont pas été affectées. Nous avons enregistré 19 incidents chez 11 animaux avec le SET, qui ont nécessité l'intervention d'un vétérinaire ou d'un membre du personnel. Deux animaux ont perdu le SET avec blessure à l'oreille. Des cicatrices dues à la migration des marques ont été observées sur les oreilles de tous les nouveau-nés après le 9e mois d'observation.

En conclusion, les SET d'un poids de 32 g qui nécessitent une fixation par deux tiges chez les bovins ne semblent pas induire d'inflammations systémiques ou locales plus fréquemment que les marques auriculaires officielles. Cependant le risque plus élevé de blessures accidentelles et de migration dans le cartilage de l'oreille ne correspondrait pas aux normes suisses en matière de bien-être et la fixation à l'oreille doit être améliorée pour une utilisation généralisée.

Mots clés: eaux, bovins, GPS, marque auriculaire à capteur, identification légale des animaux, surveillance

tutta la durata dell'esperimento, mentre gli manze adolescenti sono stati ospitati in una stalla a stabulazione libera e al pascolo durante l'estate.

Tutti gli manze hanno sviluppato croste a partire dal 7° giorno dopo la marcatura con il SET. Nelle prime due settimane sono state osservate occasionalmente reazioni dolorose. La crescita delle orecchie dei vitelle durante gli 11 mesi di osservazione non differiva tra le orecchie con il SET e quelle con la marca auricolare ufficiale. La concentrazione di cortisolo salivare dei vitelle è diminuita nella prima settimana dopo l'applicazione del sensore auricolare, il che è fisiologico per questa categoria di età. Negli manze più grandi le concentrazioni di cortisolo nella saliva non sono state influenzate. Si sono registrati 19 casi problematici in 11 manze con il SET, che hanno richiesto l'intervento del veterinario o del personale. Due manze hanno perso il SET a causa di lesioni all'orecchio. Cicatrici dovute alla migrazione della del sensore auricolare sono state osservate nelle orecchie di tutti i vitelle dopo il 9° mese di osservazione.

In conclusione, i SET del peso di 32 g che necessitano di un doppio perno di fissaggio nei bovini non sembrano indurre infiammazioni sistemiche o locali con maggiore frequenza rispetto alle marche auricolari standard tuttavia, il rischio più elevato di lesioni accidentali e di migrazione nella cartilagine auricolare non soddisfa gli standard svizzeri in materia di benessere e il fissaggio all'orecchio deve essere migliorato per un uso generalizzato.

Parole chiave: Vitelli, bovini, GPS, marca auricolare con sensore, identificazione legale degli manze; monitoraggio

References

[1] EUR-Lex. European Commission. 52011PC0525: Proposal for a regulation of the european parliament and of the council amending Regulation (EC) No 1760/2000 as regards electronic identification of bovine animals and deleting the provisions on voluntary beef labelling. eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52011PC0525&from=PT (accessed 02.11.2022).

[2] Schweizerische Eidgenossenschaft. Bundesamt für Lebensmittelsicherheit und Veterinärwesen. Technische Weisungen über die Kennzeichnung von Klauentieren. Retrieved from Schweizer Eidgenossenschaft. CH www.blv.admin.ch/dam/blv/de/dokumente/tiere/transport-und-handel/tw-kennzeichnung-klauentiere.pdf.download.pdf/TW_Kennzeichnung_Klauentieren_DE.pdf (accessed 12.09.2022).

[3] Schweizer Eidgenossenschaft. Fedlex. 916.401 Tierseuchenverordnung. CH https://www.fedlex.admin.ch/eli/cc/1995/3716_3716_3716/de (accessed 10.10.2022).

[4] Schweizerische Eidgenossenschaft. Bundesamt für Landwirtschaft. Dokumentation des Auslaufs für Tiere der Rindergattung und Wasserbüffel sowie Tiere der Pferde-, Ziegen- und Schafgattung. CH www.blw.admin.ch/dam/blw/de/dokumente/Instrumente/Direktzahlungen/Produktionssystembeitraege/Tierwohl/Auslaufjournal%20f%C3%BCr%20Weidetiere%20.pdf.download.pdf/Auslaufjournal%20f%C3%BCr%20Weidetiere%20-%20vor%20und%20nach%20dem%201.1.2017.pdf (accessed 20.11.2022).

[5] International Committee for Animal Recording. ICAR the Global Standard for Livestock Data. ICAR Registry of RFID Devices with ISO. Ultrech, NL https://www.icar.org/index.php/rfid-iso/ (accessed 20.12.2022).

[6] Johnston AM, Edwards DS: Welfare implications of identification of cattle by ear tags. The Veterinary Record. 1996: 138(25): 612–614.

[7] Caja G, Ghirardi J, Hernández-Jover M, Garín D: Diversity of animal identification techniques: from «fire age» to «electronic age», Proceedings, ICAR/FAO Seminar, Development of Animal Identification and Recording Systems for Developing Countries, Sousse, Tunisia, 2004. (Available from: ICAR Technical Series 9).

[8] Punchard NA, Whelan CJ, Adcock I: The Journal of Inflammation. Journal of Inflammation. 2004: 1(1): 1–4.

[9] Steagall P, Bustamante H, Johnson CB, Turner PV: Pain Management in Farm Animals: Focus on Cattle, Sheep and Pigs. Animals. 2021: 11(6): 1483.

[10] Dhama K, Latheef SK, Dadar M, Samad HA, Munjal A, Khandia R, Karthik K, Tiwari R, Yatoo MI, Bhatt P, Chakraborty S, Singh KP, Iqbal HMN, Chaicumpa W, Joshi SL: Biomarkers in Stress Related Diseases/ Disorders: Diagnostic, Prognostic, and Therapeutic Values. Frontiers in Molecular Biosciences. 2019: 6(91).

[11] Park SJ, Piao M, Kim H, Kang HJ, Seo J, Lee S, Baik M: Effects of castration and a lidocaine-plus-flunixin treatment on growth and indicators of pain, inflammation, and liver function in Korean cattle bull calves. Livestock Science. 2018: 216: 61–66.

[12] Leslie E, Hernández-Jover M, Newman R, Holyoake P: Assessment of acute pain experienced by piglets from ear tagging, ear notching and intraperitoneal injectable transponders. Applied Animal Behaviour Science. 2010: 127(3): 86–95.

[13] Hayer JJ, Nysar D, Schmitz A, Leubner CD, Heinemann C, Steinhoff-Wagner J: Wound lesions caused by ear tagging in unweaned calves: assessing the prevalence of wound lesions and identifying risk factors. Animal. 2022:16(2): 100454.

[14] Millman ST: Behavioral Responses of Cattle to Pain and Implications for Diagnosis, Management, and Animal Welfare. Veterinary Clinics of North America: Food Animal Practice. 2013: 29(1): 47–58.

[15] Phillips SJ: Physiology of wound healing and surgical wound care. ASAIO Journal. 2000: 46(6), S2-S5.

[16] van der Pol E, Mudde YD, Coumans FA, van Leeuwen TG, Sturk A, Nieuwland R: Wound scabs protect regenerating tissue against harmful ultraviolet radiation. Medical Hypotheses. 2016: 96, 39–41.

[17] Schweizerische Eidgenossenschaft. Bundesamt für Veterinärwesen. Technische Weisung über die Kennzeichnung von Klauentieren. CH http://www.ziegen-zwergziegen.ch/Ohrenmarken/VIII.Technische Weisungen.pdf (accessed 05.06.2022).

[18] Bauer U, Benn N, Grandl F, Kilian M, Wendl G, Harms J. Elektronische Kennzeichnung von Schafen und Ziegen zum Zweck der Rückverfolgbarkeit. Report: Bayerische Landesanstalt für Landwirtschaft, Freising. 2010.

[19] Bleeker-Rovers CP, Van der Meer JW, Beeching NJ. Fever. Common Medical Presentations. 2009: 37(1): 28–34.

[20] Schwinn AC, Knight CH, Bruckmaier RM, Gross JJ: Suitability of saliva cortisol as a biomarker for hypothalamic–pituitary–adrenal axis activation assessment, effects of feeding actions, and immunostimulatory challenges in dairy cows. Journal of Animal Science. 2016: 94(6): 2357–2365.

[21] Kovács L, Kézér FL, Bodó S, Ruff F, Palme R, Szenci O: Salivary cortisol as a non-invasive approach to assess stress in dystocic dairy calves. Scientifc Reports. 2021: 11(6200).

[22] Barrington GM, Gay JM, Evermann JF: Biosecurity for neonatal gastrointestinal diseases. Veterinary Clinics of North America: Food Animal Practice. 2002: 18(1), 7–34.

[23] Dzviti M, Mapfumo L, Muchenje V: Relationship between saliva and blood cortisol in handled cows. Asian-Australasian Journal of Animal Sciences. 2018: 32(5), 734–741.

[24] Curtis, M. Farmers Weekly. Tag loss variation shock. Sutton, UK https://www.fwi.co.uk/news/tag-loss-variation-shock (accessed 22.10.2022).

[25] Identitas. Tierstatistik. Ear Tag Orders. Bern, CH tierstatistik.identitas.ch/en/cattle-eartag.html (accessed 19.12.2022).

[26] Hosie B: Problems with the use of ear tags in sheep. Vet Rec. 1995: 137(22): 571.

[27] Schweizerische Eidgenossenschaft. Bundesamt für Lebensmittelsicherheit und Veterinärwesen. Markieren von Schafen und Ziegen – Umfrage und Feldversuch zu den Ohrmarken sind abgeschlossen. CH www.blv.admin.ch/dam/blv/de/dokumente/tiere/transport-und-handel/fm-ohrmarken.pdf.download.pdf/D_Markieren%20von%20Schafen%20und%20Ziegen%20%E2%80%93%20Umfrage%20und%20Feldversuch%20zu%20den%20Ohrmarken%20abgeschlossen.pdf (accessed 10.06.2022).

[28] Ueda K, Heikkilä U, Kuntzer T, Gobbo Oliveira Erünlü N, Bérard J, Wellnitz O, Beglinger C, Rieder S: Fernkontrolle von Rindern in der Schweiz mittels einer Sensorohrmarke. Agrarforschung Schweiz. 2023: 14: 104–115.

Korrespondenzadresse

Olga Wellnitz
Agroscope, Animal Production Systems and Animal Health
Route de la Tioleyre 4
CH-1725 Posieux
Telefon: 0041 58 467 42 43
E-Mail: olga.wellnitz@agroscope.admin.ch