Ear tag mechanical properties under extreme climate conditions

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Abstract

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The common ear tag production and application do not take into regard the demographic environment and climate of a target destination which are specified. However, this fact becomes a core of the problem. The necessity to characterize the ear tag bond comes out from the practical experience when applying incorrect exchange spike in the application punch by mistake. The aim of the experimental research was to carry out the evaluation of the ear tag mechanical qualities under increased and decreased temperatures on the base of the laboratory experiments together with the suitable and incorrect application of the exchange spike in the application punch. Different environment temperatures in the tested interval –20°C till 60°C should simulate one of the possible attribute of the potential application in the different climate. The constructional design of the ear tag bond was proposed on the basis of the laboratory tests.

Keywords: application punch; function tests; identification; farming; animals; temperature

A credibility of classical ear tags of cattle and sheep is inevitably necessary for reaching the identification and ensuring the identity requirements of each animal in case of the loss or damage of the tag. Picking out reached source data is completely wrecked in the case of the damage even the loss of the ear tag. Not less significant attribute is an elimination of uncalled animal injuries when applying the identification device. The injury can be caused by unsuitable exchange spike used in an application punch. All breeders in the EU as well as in the world are obliged to identify and record the farming animal prospectively, it is an integral condition of the animal production import into developed countries. This fact makes the problem actual.

Identifying the animals is very important mainly for distinguishing the animals, their fast defining in the herd and of course for correct recording. It is also used as an instrument for a disease observing. For these the reasons accurate identification of animals is so important.

The animal identification can be carried out in more ways, the most frequent are following: ear tags, tattoo, branding, word and graphic description or electronic identification (Caja et al. 2004). Foreign researches devote to biometric identifi-

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cation as well (Allan et al. 2008). Regarding the economic and technical background, population education and staff experience the animal identification has to be simple, functional and with low input cost, mainly in developing countries. Mongolia can be mentioned as the sample which is distinguished for high potential of the first-quality animal production and the high number of the farming animals (Tomeš et al. 2010). The optimum method for identifying the animals can be characterized by analysing the input parameters reached from the animal breeders as the method which has to fulfil following attributes: it has to be easy to apply, reliable, applied to huge number of animals during the short time, the application must not injure animal nor affect the animal welfare, it has to be hygienic and with low economic demands.

Identifying the animals by means of the plastic ear tags fulfil all the above mentioned requirements. Using this method of identifying it is inevitably necessary to secure the identification to be easy to find out, good legible, durable, fixed against the loss and safe when identifying the animal. It has to be resistant against the loss of the legibility and not re-usable (Caja et al. 2004).

Plastic ear tags are the safest method for identifying the farming animals in many countries these days. If they are well produced, designed and adapted to an animal type and breed, they are recommended choice for identifying the farming animal (Caja et al. 2004). Metal ear tags injure animal more than polyurethane ones (Johnston, Edwards 1996). The difference was observed mainly at little calves.

A potential problem of the above mentioned animal identification system is the ear tag loss or damage and the impossibility to find the animal for subsequent identification, mainly in large herds which are not perseverant and regularly controlled. The sample of the ear tag loss is its catching in a bush when the animal is going through (Matete et al. 2010). Subsequently it is necessary to identify the animal with the ear tag with the same number and the statement that it is the duplicate.

The specific application punch is the second limit (Caja et al. 2004). The animal injury or the ear tag damage menace when using exchange spikes.

Analysing various farming animal identification systems some conclusions concerning ear tag application can be stated:

– for all animal types,
– middle animal welfare,
– middle input costs,
– low required skills of staff,
– middle lifetime,
– middle legibility of text (Caja et al. 2004).

Common ear tag production does not deal with the issue of a physical resistance of the final product under extreme conditions. However, only chemical qualities of the extruded granulate were stated with regard to a chemical stability and biological unexceptionable character.

The experience and observations reached during the working stay abroad provoke the necessity to test the ear tags not only under EU conditions, but also under extreme climate conditions in those countries which started to harmonize to the conditions in accordance with the EU legislation (Lukešová 2009).

Today, globalized society intervened undoubtedly in the field of the ear tag production and application; the specific environment climate of a target destination is not often taken into regard, but as early as in their production. Also the animal welfare is not often respected. Subsequently this fact becomes, however, problem many times. That is why the ear tag mechanical qualities have to be dealt with from different points of view, for the practical needs most of all in developing countries.

The aim of the experimental research was to carry out, on the basis of laboratory experiments, the evaluation of the ear tag mechanical qualities under increased and decreased temperatures and to simulate extreme climate conditions of their application in this way. New constructional design of farming animal ear tag will be possible to propose on the basis of the laboratory experiments that simulated a deformation or destruction of the ear tag connection and on the basis of a consultation with the expert from the Institute of Tropics and Subtropics, CULS, Prague dealing with animal breeding in developing countries.

MATERIAL AND METHODS

The solving methodology is based on the experimental processing of measured data. Tests under temperatures in the interval –20°C till 60°C were carried out on the basis of the potential environment analysis. Limits and advantages of common ear tag model produced by a significant firm in the EU will be able to set on the base of the laboratory results.

Tested samples. Today market offers ear tags which are created by the fore part with a hole and by the back part with a pin. A connection of both parts

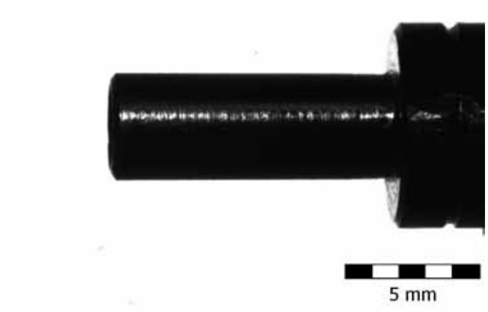

Fig. 1. Exchange spike for cattle ear tags

Fig. 2. Exchange spike for sheep ear tags

is carried out by means of the application punch which has exchange spikes. When creating a bond by means of the application punch the back part with the pin is pressed into the fore part with the hole. This causes a plastic deformation around the hole. This fact decreases strength characterization of a given bond. Exchange spikes in the application punch differ for cattle and sheep. An incorrect application of the spike causes the ear tag damage, the animal injuries and also wrong connection leading to the identification ear tag loss. Objective technical solution eliminates the above mentioned minuses due to its constructional setting.

Polyurethane ear tags for cattle and sheep were tested. The application of these tags is carried out by means of the application punch Ritchey equipped with the exchange spike for the cattle ear tags (Fig. 1) and the sheep ear tags (Fig. 2). The spike of the cattle ear tag penetrates the animal ear by means of a conic metal spike whereas the spike of the sheep ear tag is made from the hard plastics.

Four variants were tested:

– the bond of the cattle ear tag connected by means of the application spike determined for the cattle ear tags (further described as CC),
– the bond of the sheep ear tag connected by means of the application spike determined for the sheep ear tags (further described as SS),
– the bond of the cattle ear tag connected by means of the application spike determined for the sheep ear tags (further described as CS),
– the bond of the sheep ear tag connected by means of the application spike determined for the cattle ear tags (further described as SC).

Specification of testing environment. Mechanical qualities of the polyurethane such as strength limit, hardness, persistence and so on change due to temperature. The marginal temperature for using the polyurethane is stated in the interval –40 till 80°C. Regarding the potential variance of the environment in the place of the ear tag application the testing environment was frame in laboratory chambers in the temperature regime of –20°C (–4°C), 0°C (6°C), 20°C (18°C), 40°C (30°C) and 60°C (48°C). The temperature of the ear tag surface in the given environment is stated in brackets. The temperature of the tested ear tag surface was measured by means of the laser contactless thermometer Testo 845 (Testo, Prague, Czech Republic).

Testing methods. The loss (destructive damage) simulation of the ear tag bond was tested on the Schöper machine (VEB Werkstoffprüfmaschinen, Leipzig, Germany). The loading of the ear tag bond was combined (shear tensile), the deformation speed was 250 mm/min. High speed of the deformation simulates the dynamism of the animal ear jerk.

The measurement output was the connection maximum force *F* (N). The approximate connection area and the tension σ (MPa) calculated according to the Eq. (1) were possible to quantify on the basis of the picture analysis of the ear tag bond carried out by means of the stereoscope. A bearing area of the cattle ear tag section was measured as 20.78 mm^2 and the sheep ear tag as 18.37 mm^2.

$$\sigma = \frac{F}{S_{\text{microscope}}} \quad (1)$$

where:

σ – tension in shear tensile when breaking (MPa)
F – relevant measured tensile force of ear tag bond destruction (N)
$S_{\text{microscope}}$ – bearing area of ear tag section found out by means of picture analysis (mm^2)

Second significant attribute of the polyurethane mechanical behaviour is a hardness change. Materials which are cooled change significantly their mechanical qualities in the negative way, i.e. they become brittle and loose their flexibility. The material hardness was measured by Shore D method, i.e. pushing the spike into the equipment durometer Shito HT-6510D (Shanghai Total Meter Co., Shanghai, China).

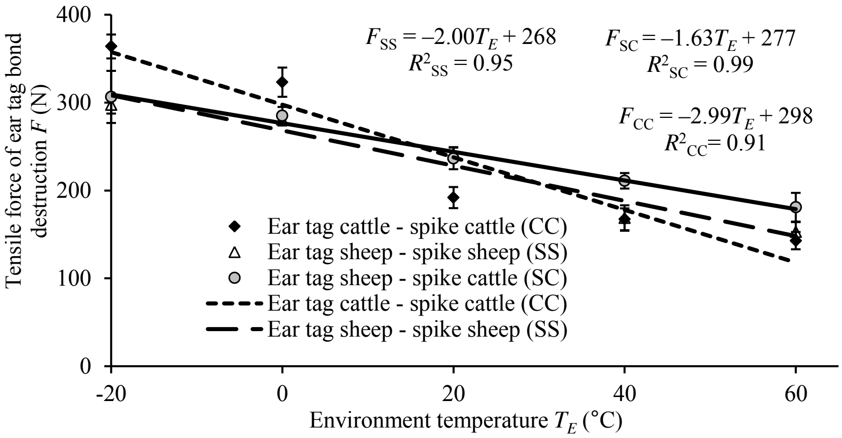

Fig. 3. Influence of environment temperature on tensile force when destroying polyurethane ear tag bond

The hardness measuring by Shore D method according to the standard ČSN EN ISO 868 (rok??, není v References) requires testing samples at least 4 mm thick. Ear tags did not fit this marginal dimension. The ear tag thickness was measured as 1.53 ± 0.02 mm. This fact has led to piling up 6 cuts of ear tags and creating the testing sample for hardness measuring. The standard enables this process.

RESULTS AND DISCUSSION

Fig. 3 shows the destructive testing results of ear tag bonds for each variant. A decreasing linear trend of the tensile force necessary to the ear tag bond destruction depending on the temperature is obvious from the results.

The reason is the raising hardness Shore D with increasing negative temperature (Fig. 4). The polyurethane material is less flexible and so it is possible to reach higher strength of the bond in return deformation of the pin through the input hole than the flexible material, i.e. under temperatures ranging about 60°C. The cut of the cattle ear tag bond is in Fig. 5. A pointed conic part of the spike overlaps of 0.39 ± 0.08 mm, which may cause an injury. Fig. 6 presents the cut of the sheep ear tag bond.

At destructive testing, the cattle ear tag bond connected by means of the application spike determined for the cattle ear tag bond and no problem occurred, that is, the pin was jerked out from the second part of the ear tag in 100% cases. When breaking a bond calculated tension in shear tensile ranged in the interval ca. 17.5 till 6.9 MPa depending on the temperature. Higher values were reached under negative temperatures.

At destructive testing the sheep ear tag bond connected by means of the application spike determined for the sheep ear tag bond the destruction of the polyurethane neck occurred in 100% of cases under the temperature of –20°C. Under the temperature of 0°C plastic end of the pin was destroyed in 90% of cases (Fig. 7) and the polyurethane neck was destructed in 10% of cases (Fig. 8). Under the temperatures of 40 and 60°C the pin damage occurred in order in 40 till 50% (Fig. 7). The calculated tension in shear tensile ranged about ca. 16.2 till 8.3 MPa depending on the temperature when breaking the bond. Higher values were reached under negative temperatures.

At destructive testing the cattle ear tag bond connected by means of the application spike determined for the sheep the spike was damaged and the bond destruction occurred already after 15th application (Fig. 9). For the above mentioned reason the tensile force of the ear tag bond 209 ± 7.2 N was set only under the temperature of 20°C. Calculated tension in shear tensile was ca. 10 MPa when breaking the bond. Results show that mistaking the application spike determined for the sheep ear tag leads to the spike damage excluding the bond crea-

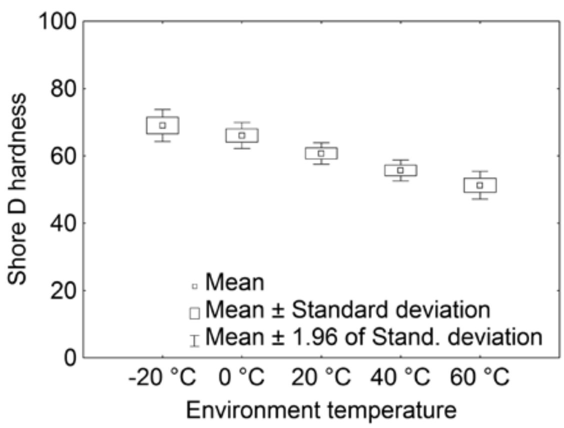

Fig. 4. Influence of environment temperature on polyurethane ear tag hardness

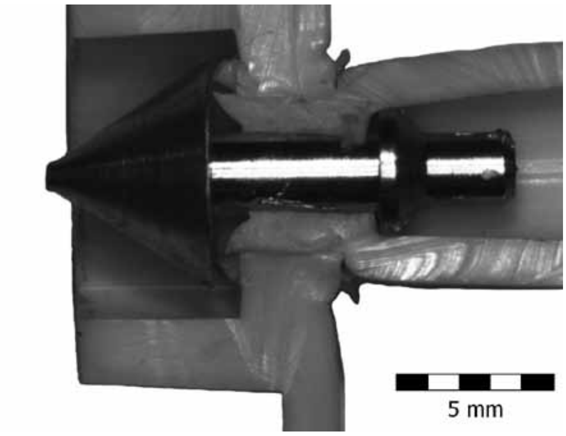

Fig. 5. Cut off ear tag bond determined for cattle

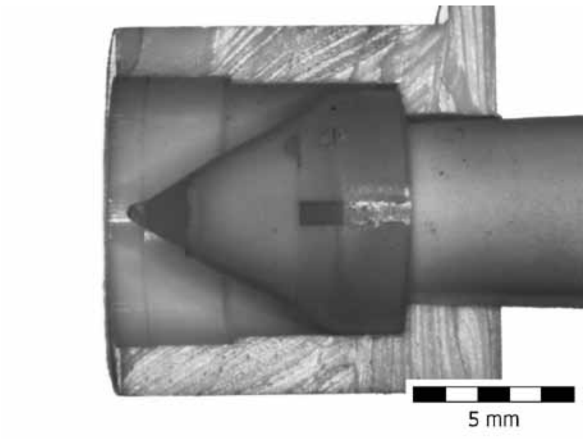

Fig. 6. Cut off ear tag bond determined for sheep

tion. Also the application is very difficult and the inconvenience can be visually seen at Fig. 10.

At destructive testing the sheep ear tag bond connected by means of the application spike determined for cattle the destruction of the polyurethane neck occurred in all cases under the temperatures of –20 and 0°C. The source of the damage was found out when the polyurethane neck was fully investigated. The source of the damage was the spike determined for the cattle ear tag application whose diameter is about 150% larger than the application spike of the sheep ear tag. At destructive testing under the temperature of 20°C the deformation of the polyurethane neck occurred, that is the analogy of the Fig. 8. Under the temperature of 40°C the plastic end of the pin was damaged in 10% of the cases, that is the analogy of the Fig. 7. Under the temperature of 60°C the pin damage raised to 60%. The pin is finished with the plastic cones which serve for the penetration through the ear. From the above stated measurements the material is probably the reactoplastics which cannot be shaped under increased temperatures.

When breaking the bond, the calculated tension in shear tensile ranged in the interval 16.7 till 9.8 MPa depending on the temperature. Higher values were reached under negative temperatures. Repeated use of the cattle ear tag bond connected by means of the application spike determined for the cattle ear tag bond is possible. The tensile force of the destroyed bond of repeated used ear tags is 183 ± 6.9 N under the environment temperature of 20°C, that is about ca. 4.5% decrease against new ear tags. This fact is dangerous owing to relevant intentional change of the animal identification. This problem could be eliminated by means of the pin shearing edge which would controllably deform during the repeated passage through the second counterpart of the ear tag.

Experiments results and consultations with the expert from the Institute of Tropics and Subtropics, CULS, Prague focusing on the farming animal breeding allowed to propose a constructional design of the farming animal ear tag which is solved with an application form of the utility pattern CZ 22091 U1 (Müller, Lukešová 2011).

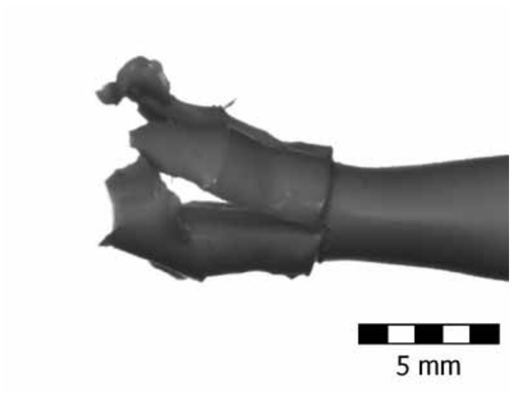

Fig. 7. Destruction of pin plastic end – ear tag for sheep

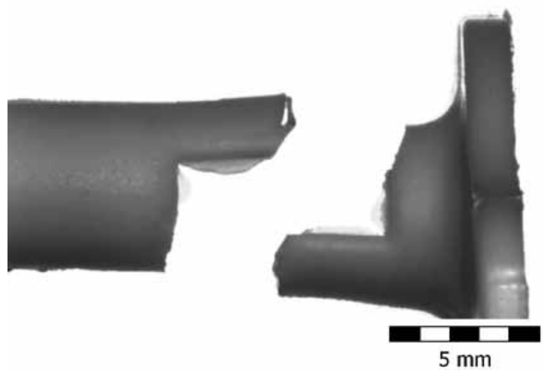

Fig. 8. Destruction of polyurethane neck – ear tag for sheep

Fig. 9. Detail of application spike tip damage caused by unsuitable application

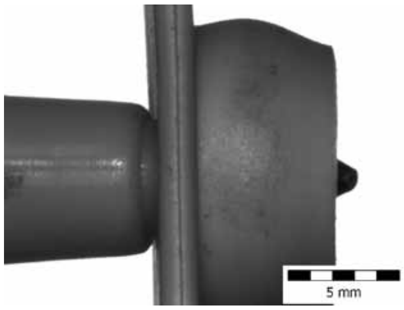

Fig. 10. Ear tag connection deformed because of unsuitable application spike

CONCLUSION

Experiment results claimed the possibility to change the exchange spikes in the application punch. Insufficiently educated staff can cause the injury of the identified farming animal ear when using unsuitable application spike, mainly when applying the cattle ear tags by means of the application spike determined for the sheep ear tag bond. The broken top of the application spike causes a hole in the tag neck which goes through the ear of the identified animal during the practical application.

Negative environment temperatures till –20°C are not limited from the tensile force necessary for destroying the connection point of view. On the contrary it comes to the raise of the forces which are necessary to the destruction and subsequent loss of the identifying device in the mean of the ear tags. The raising hardness and connected prospective brittleness are the limiting agent. In the marginal cases the ear tag can break and it makes legibility difficult. The hardness increase can negatively manifest in similar way as metal ear tags when injuring the animal.

Increased tested temperature till 60°C showed the opposite trend; that is a decrease of the force which is necessary for destroying the ear tag bond and a decrease of the ear tag hardness at the same time.

Entirely trouble free re-usage of the ear tag is the serious problem. The test results enabled to propose the technical design of the farming animal identifying device by means of two part cattle and sheep ear tag connected by means of the deformable spike non-requiring the plastic deformation in the place of the spike bedding in the ear tag and with the possibility to set the maximum force needed to "disjoin the bond" eliminating the animal ear injure at the same time.

References

Allan A., Golden B., Tailor M., Patterson D., Henriksen D., Skuce R., 2008. Evaluation of retinal imaging technology for the biometric identification of bovine animals in Northern Ireland. Livestock Science, *116*: 42–52.

Caja G., Ghirardi J.J., Hernández-Jover M., Garin D., 2004. Diversity of animal identification techniques: from „fire age" to „electronic age". ICAR Technical Series, *9*: 21–39.

Johnston A.M., Edwards D.S., 1996. Welfare implications of identification of cattle by ear tags. Veterinary Record, *138*: 612–614.

Lukešová D., 2009. Identification of Animals in Central Region (Mongolia). Available at http://www.vetnaadam.org/CZ/zamer.php

Matete G.O., Maritm W., Muchemi G., Maingi N., Gathuma J.M., Ogara W., 2010. Long-term performance of electronic identification devices and model traceability system for cattle under pastoral production systems of Kenya. Available at http://www.lrrd.org/lrrd22/10/mate22181.htm (accessed October 2010).

Müller M., Lukešová D., 2011. Spoj ušní známky s deformovatelným trnem (Ear Tag Joint with Deform Table Pin). Pattern No. CZ 22091 U1.

Tomeš J., Müller M., Lukešová D., 2010. Livestock ear tag's laser print resistance in conditions of mongolia climate. Agricultura Tropica et Subtropica, *43*: 216–221.

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