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Long term performance of RFID technology in the large scale identification of small ruminants through electronic ceramic boluses: Implications for animal welfare and regulation compliance

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A B S T R A C T

Animal health and welfare together with technical aspects relating to the RFID based electronic identification (EID) of a total of 114,857 small ruminants, reared in 268 semi-extensive farms, were assessed in Sarda ewes, Sarda and Sarda × Maltese goats, over a period of six years (2006–2011). A multi-purpose investigation was carried out to: (1) monitor the effects on the health and welfare of electronically identified (EID) sheep and goats in farms; (2) support technicians and veterinary practitioners, during fieldwork (decision making) should problems arise relating to EID small ruminants, on a large scale. A coded manual of operations for EID problem solving was drawn up to support an experimental help desk service (HDS). The HDS relied on the technological breakthrough due to the improvement of radiological analysis (digital X-ray): such technology was used to check the performance of the RFID bolus (composed of a RFID device: transponder, and a ceramic case) directly on farms, in relation to its retention and the functioning of the transponder (carrier of the electronic individual code, EIC) in the animal body. The occurrences of administration accidents of the bolus were recorded; undetectable EICs in relation to the different types of devices deployed were listed as: loss, breakage, malfunctioning, doubled code/device fraud. The ceramic boluses currently in use were seen to vary considerably in terms of dimensions (length and width) and mass, as follows (in descending order): 70 mm × 21 mm, 72 g; 70 mm × 18 mm, 70 g; 66 mm × 18 mm, 50 g; 58 mm × 12 mm, 20 g. All kinds of ceramic bolus held an inner transponder (32.5 mm × 3.8 mm, 134.2 kHz), according to ISO standard 11784. Digital X-ray in the field was a useful tool to assess the localization of the transponder/bolus or both in the animals' body, after ectopic detection or un-detection of the transponder's EIC. Accidents in bolus administration took place in 0.093% of cases, ranging in severity from mild (0.075%: bolus stopped in the oro-pharynx or in the naso-pharynx, X-ray checks are useful in the latter occurrence) to lethal (0.011%: bolus in trachea; 0.007%: oesophageal rupture, found at necropsy). A significant ($p < 0.001$) loss rate (0.369%) involved both sheep and goats identified by means of a 20 g bolus, whereas the loss rate strongly decreased when 70 g (0.005%) or 72 g (0.002%) bolus was used, observed significantly in goats ($p < 0.05$).

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1. Introduction

The safety, efficacy and reliability of livestock identification represent the cornerstones of an accurate system for traceability (Caja et al., 1996, 1999; Regulation (EC) 178/2002; Caja et al., 2004; Pinna et al., 2007, 2010; Cappai et al., 2008; Cappai and Pinna, 2012). Problems due to the lack of a reliable identification system include, among others, loss of the identification device, switching of devices between animals, difficulties in knowing the true number of animals on farms and unidentified animals, as reported by Pinna et al. (2007). An appropriate system of animal identification is a fundamental step for up-to-date farm registers: the responsibility of the farmer (ownership) plays a key role in the early phase of the whole value chain in the animal production sector. In EU countries, particular attention is being paid to livestock diseases and zoonoses and a series of regulations is being issued. The increasing awareness of the need for a reliable identification system for livestock from birth to the slaughterhouse, in order to monitor farm animals and their movements, has been proposed for small ruminants (EC Reg. 21/2004, EC Reg. 933/2008; EC Reg. 759/2009) based on the unique identification of each animal, including radio frequency identification (RFID) technology among the systems on farms, as reported in Annex I of the EC Reg. 21/2004. Nevertheless, specific technical features of devices are not considered. A passive (non-battery) transponder allows the automatic reading of the code associated with the animal and provides a reliable and valuable method for recording data in a digital format. The use of individual electronic identification appears to offer several advantages, such as the automation of routine tasks and the reduction of time and human error during performance recording and data transfer (Caja et al., 1996, 1999). However, the long term evaluation of the technical performance of radio frequency identification (RFID) technology for the individual electronic identification of small ruminants represents a concern. The introduction of the new technology and its deployment on a large scale has proportionally given rise to a series of problems which currently emerge in field practice. Since 2009 (EC Reg. 21/2004), when individual electronic identification became mandatory for newborn sheep and goats, a huge variety of devices for animal identification have appeared in the market in European countries. However, regulations indicate that all transponders used for animal identification must comply with ISO Standard 11784, in order to be licensed for use for small ruminant identification in EU countries. Due to the considerable variation in typologies of RFID bolus (namely, a ceramic case with an inner transponder, 134.2 kHz, administered *per os* to ruminants) used, a wide array of different technical problems may arise. In Sardinia, the numbers of small ruminants reared up to 2012 were 3,206,821 sheep and 216,536 goats, representing 45.7% and 24.3% of all the sheep and goats reared in the whole of Italy, respectively (ISTAT, 2013). With regard to the electronic identification of livestock, the farmers association (APA) of the Province of Nuoro participated in experimentation of the electronic identification of sheep and goats, in the IDEA (Ribó et al., 2003) and IESA (Electronic Identification Sardinia) projects, in cooperation with the Joint Research Center of Ispra, in 2006. A problem solving driven Help Desk was later created, on the basis of observations made in the field, which could act as a representative reference point for the large scale deployment of RFID in non-experimental farms: such technical and veterinary experimental support aimed to gather, catalogue and set up a code of procedures to address, resolve and prevent both veterinary complications and technical problems relating to RFID technology and the diversity of devices used for the electronic identification of sheep and goats. The experimental HDS was conceived also thanks to the technological breakthrough due to the improvements in digital radiological analysis (digital X-ray): such technology was used to check the performance of RFID devices and confirm the occurrence of accidents during the administration of the boluses to the animals.

2. Materials and methods

2.1. Animals and farms

A total of 114,857 small ruminants (EID Sarda sheep: 97,628; EID Sarda goats and Sarda × Maltese goats: 17,229) reared in 268 semi-extensive dairy farms, were monitored between 2006 and 2011, after individual electronic identification of animals by way of oral administration of the RFID bolus. All the farmers involved in the experimental HDS were members of the APA and were supported by two trained APA technicians per farm, during the activities for the electronic identification of sheep and goats.

Animal handling followed the recommendations of the European Union Directive 86/609/EEC and Italian law 116/92 concerning animal care and, later, of 2010/63/EU, where applicable, specifically with regard to Art. 1, point 5, letter (b).

All sheep involved were recorded in the Genealogical Register of Sarda breed and the number of animals per farm was between 135 and 756. The animals were individually identified by ear tags in accordance with current health guidelines as well as by ear tattoos. The semi-extensive farming system allowed sheep to graze during the day on green pastures in plain areas, sheltered during the night and supplemented with hay in the barn and concentrates (either raw whole grains or pelleted supplementary feed) at milking (twice a day) during the lactation period, or solely with hay and concentrates in the dry period due to the scarcity of fresh fodder during summer and early autumn.

All Sarda goats were recorded in the flock register of the Sarda goat breed. On all the goat farms, flock size ranged from 54 to 457 animals. The semi-extensive farming system allowed goats to graze during the day on poor pastures in bushy areas on hills and mountains, sheltered during the night and supplemented with hay in the barn and concentrates (either raw whole grains or pelleted supplementary feed) at milking (twice a day) during the lactation period.

The productive performance (individual and bulk milk production) was usually monitored once a month by the APA technicians (different teams composed of 2 technicians per farm) on each sheep and goat farm, throughout