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Performance of electronic and visual ear tags in lambs under extensive conditions in Turkey

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Abstract. The objective of this study was to evaluate the effectiveness of electronic and visual ear tags in animal traceability, and to investigate the effect of placement site on ear-tag retention in Akkaraman lambs under rural conditions. A total of 380 lambs were identified with electronic and visual ear tags. Electronic and visual ear tags displayed 98.9 and 98.7 % readability at the end of 7 months, and 98.0 and 98.0 % readability at the end of the first year after tagging, respectively. Regarding the placement site, it was observed that there was more loss in ear tags placed on the mid-point part of the ear than the first-quarter part from the head side, but the difference was not statistically significant ($P > 0.05$). Breakages and electronic failures were not recorded during this study. In conclusion, electronic and visual ear tags demonstrated similar on-farm efficiency for the identification of Akkaraman lambs and fulfilled the minimum efficiency of 98 % required by the International Committee for Animal Recording (ICAR) for an official animal identification device at the end of the first year after tagging. Based on the findings of the study, placement of the ear tag in a cranial position and near the base of the ear would be advised.

1 Introduction

In order to guarantee food safety and quality, due to the decreasing consumer confidence caused by disease outbreaks (BSE, FMD, swine fever, avian influenza, etc.) and food-related safety hazards (dioxin, melamine, microbial contamination of fresh produce, etc.), a need for a reliable traceability system for animals and animal products has emerged.

The World Organisation for Animal Health (OIE) defines animal traceability as “the ability to follow an animal or group of animals during all stages of life” (OIE, 2011). The traceability process starts initially with the identification and registration of animals individually. The “farm-to-fork” approach in traceability, which requires robust and effective systems, could be successful only if a reliable and permanent animal identification system is implemented.

As conventional animal identification methods are ineffective, due to reasons such as losses, code erasing, short reading distances, transcription errors, negative effects on welfare, and fraud (Caja et al., 2005), these systems are also far from satisfying the traceability requirements of the modern livestock industry. Therefore, electronic identification systems based on RFID (radio frequency identification) technology have been developed for permanent animal identification. Electronic identification considerably facilitates the implementation of traceability systems. Pinna et al. (2006), who applied a questionnaire to technicians and farmers in order to determine the practical use of electronic identification systems, reported that there was satisfaction with and interest in the electronic identification system because the official animal identification systems currently used were not satisfactory.

Readability and retention rate of electronic (e-ETs) and visual (v-ETs) ear tags are affected by ear dimensions, environment, and ear-tag features (Caja et al., 2014). The retention of e-ETs and v-ETs in lambs has shown remarkable variability, ranging from 85.4 to 100 % in e-ETs (Thomas et al., 2006) and 91.7 to 100 % in v-ETs (Caja et al., 1999, 2007; Conill et al., 2002; Ghirardi et al., 2007). In addition, the tagging site on the animal’s ear is critical for its retention (Caja et al., 2004). The most common ear-tag placement site in animals is in the middle of the ear. It is recommended that the ear tags

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be placed on the first quarter of the animal's ear between the two cartilage ribs for the greatest retention in cattle (Buskirk, 2006). Buskirk (2006) reported that "tags placed too far from the head will increase the probability of snagging on objects, reducing retention and making the animal's ear susceptible to tearing". The placement site together with ear-tag type is significantly associated with the retention of ear tags and severity of ear lesions. Taking the species and rearing system into account, ear tags should be applied to a site that cannot damage the ear or cause too much ear-tag loss.

In Turkey, all sheep and goats have been identified with official plastic ear tags, vaccinated against PPR disease and recorded in the TURKVET database, countrywide. However, from 2015, electronic identification using e-ETs has been implemented within the electronic identification and registration system for sheep and goats in order to follow animal movements and control animal diseases. Literature review demonstrated that there were no studies on the use of e-ETs for electronic identification of lambs in Turkey, and literature on the effects of placement site on retention of ear tags was not available. The objective of this study was to evaluate the effectiveness of electronic and visual ear tags in animal traceability and to investigate the effect of placement site on ear-tag retention in Akkaraman lambs under rural conditions.

2 Material and methods

2.1 Administration and monitoring of identification devices

The experimental procedures were approved by Yüzüncü Yıl University Ethical Committee on Animal Experimentation (reference no 2012/06). Akkaraman lambs used in this study were reared under extensive conditions in a rural farm in Van province in eastern Turkey. A total of 380 lambs born in the 2014 lambing season were identified with e-ETs (Allflex) applied on left ears and v-ETs officially approved by the Republic of Turkey Ministry of Food, Agriculture and Livestock on right ears. Birth date, birth weight, birth type, gender, ear tag number, and identification number and age of dam were recorded at time of birth. Lambs were kept with their dams in a barn for 20 days after lambing. Then, lambs were separated from their dams during the daytime and kept together during the night-time until weaning (4 months of age). There was a separate pen for pregnant ewes and lambs, and concrete water troughs in the barn. The barn was surrounded by a large, wood-fenced yard. There were wooden feeders in the yard. Lambs and dams were kept as separate flocks on pasture.

Electronic ear tags containing an FDX-B (full-duplex B) transponder and working at an activation frequency of 134.2 kHz in accordance with ISO 11784 and 11785 standards (ISO, 1996a, b) were used. The button–button e-ET had a weight of 6.6 g and diameter of 27.5 mm. The flag-type v-ET's total weight was 4 g and the dimensions for female and male pieces were 38 × 40 and 38 × 35 mm, respectively. Both types of ear tags, which were tamper-proof, plastic (polyurethane), and yellow in color, also had a laser-printed unique identification number. The ear tags used are displayed in Fig. 1. In order to investigate the effect of placement site on retention of ear tags, both ear-tag types were applied on the same animal either at the mid-point part (1/2) or the first-quarter part (1/3) of the ear from the head side.

Figure 1. Electronic and visual ear tags used for the identification of lambs.

The retention rate and readability of e-ETs and v-ETs post-insertion were evaluated on farm conditions for a period of 1 year, biweekly until the 3rd month, and thereafter monthly until the 12th month. The study was conducted on 197 lambs until the 12th month, because 183 male lambs were sold at the end of 7 months. Electronic ear tag readings were performed under static conditions in restrained animals using a hand-held transceiver (Agrident APR500) with a built-in keyboard and integrated antenna. The reader allows the introduction of birth records and official identification number of the animal linked with the electronic identification code. Also, each e-ET was read in dynamic conditions by using an ISO-compliant reader, which was connected to a 94 × 52 cm frame antenna installed on a plastic panel, which was able to read at a maximum distance of 100 cm for e-ETs. For this purpose, the panel reader was mounted on the left side of a runway (width 50 cm). When the animals passed in front of the antenna, an electronic identification number appeared on the personal computer screen and data from the panel reader were transmitted to the PC.

An e-ET that was unreadable, but robust, was considered as electronic failure. Both ear-tag types were also monitored for loss, damage (breakage, signs of gnawing, etc.), and ear tissue reactions at each reading control. Unreadable devices were due to either loss or device failure (Carne et al., 2009). When tags were missing, the date was recorded and the animal was re-tagged. The readability (R) and dynamic reading efficiency (DRE) of ear tags were calculated using the following formulas: R (%) = (n readable devices/n applied devices) × 100 (Caja et al., 2014); DRE = (n read transponders/n readable transponders) × 100 (Caja et al., 1999).

Table 1. Performance of identification devices in lambs.

		Electronic ear tags			Visual ear tags		
	Item	Overall	1/2	1/3	Overall	1/2	1/3
Birth to 7 months of age							
	Administered, *n*	380	190	190	380	190	190
	Lost, *n* (%)	4 (1.1)	3 (1.6)	1 (0.5)	5 (1.3)	4 (2.1)	1 (0.5)
	Electronic failures[1], *n* (%)	0	0	0	–	–	–
	Readable, *n*	376	187	189	375	186	189
	Readability, %	98.9	98.4	99.5	98.7	97.9	99.5
	DRE[2], %	100	100	100	–	–	–
8–12 months of age							
	Previous[3], *n*	197	93	104	197	93	104
	Administered, *n*	0	0	0	0	0	0
	Lost, *n* (%)	3 (1.5)	2 (2.2)	1 (1.0)	0	0	0
	Electronic failures, *n* (%)	0	0	0	–	–	–
	Readable, *n*	194	91	103	197	93	104
	Readability, %	98.5	97.8	99.0	100	100	100
	DRE, %	100	100	100	–	–	–
Birth to 12 months of age							
	Administered, *n*	197	93	104	197	93	104
	Lost, *n* (%)	4 (2.0)	3 (3.2)	1 (1.0)	4 (2.0)	3 (3.2)	1 (1.0)
	Electronic failures, *n* (%)	0	0	0	–	–	–
	Readable, *n*	193	90	103	193	90	103
	Readability, %	98.0	96.8	99.0	98.0	96.8	99.0
	DRE, %	100	100	100	–	–	–

[1] The number of unreadable transponder with electronic readers; [2] dynamic reading efficiency (*n* read transponders/*n* readable transponders × 100); [3] one hundred eighty-three male lambs were sold at 7 months of age.

2.2 Statistical analysis

Performance of ear tags and placement site were analysed by means of the Cox proportional hazard (Cox, 1972) procedure. Non-significant factors (gender, birth type, and birth weight) were removed from the model. As previously used by Carne et al. (2009), a non-parametric Kaplan–Meier survival analysis and log-rank tests of equality across strata were performed to assess the difference in survival times between the ear tags and placement site. All analyses were performed in SAS (2005) and SPSS statistical software (v.20).

3 Results and discussion

Results on the performance of e-ETs and v-ETs in lambs are presented in Table 1. Electronic and visual ear tags displayed 98.9 and 98.7 % readability, respectively, in static conditions on 380 animals at the end of 7 months. The performances of ear tags are mainly dependent on their losses caused from tag breakage or ear splitting (Caja et al., 2014). In total, four tag losses (1.1 %) were recorded in e-ETs, which occurred in the second, third, fourth, and seventh months after tagging. For v-ETs, all tag losses (five tags, 1.3 %) were observed in the first month. Two e-ET losses occurred because of ear splitting, while two e-ETs were pulled free from the ear due to enlarged holes. Split ears were not observed for v-ET losses; however five cases of loss were registered as damage to the flag piece of v-ETs. The difference between the lost cases of e-ETs and v-ETs may be explained by factors such as the size, shape, and type of material of the tag. As a consequence, readability of e-ETs and v-ETs at 7 months was similar. Readability of e-ETs and v-ETs almost reached the ≥ 99 % value recommended by the International Committee for Animal Recording (ICAR) at the sixth month after tagging (ICAR, 2012).

Regarding the placement site, loss rate in e-ETs placed on the 1/2 and 1/3 part of the ear was 1.6 % (three tags) and 0.5 % (one tag), respectively. Visual ear tag loss rates were 2.1 % (four tags) for the 1/2 part and 0.5 % (1 tag) for the 1/3 part of the ear. No statistically significant difference between the loss rates based on ear-tag types and placement site was found. Readability of ear tags (98.4 % for e-ETs, 97.9 % for v-ETs, 96.3 % overall) placed on the 1/2 part of the ear did not reach the ICAR value, whereas ear tags placed on the 1/3 part of the ear had readabilities of ≥ 99 % at 6 months after tagging as recommended by ICAR. Thomas et al. (2006) reported that the overall loss of e-ETs was 9.9 % for sheep in 4.5 months and 19.2 % for lambs in about 3 months, and these lost rates were unacceptably high for official use. Elec-

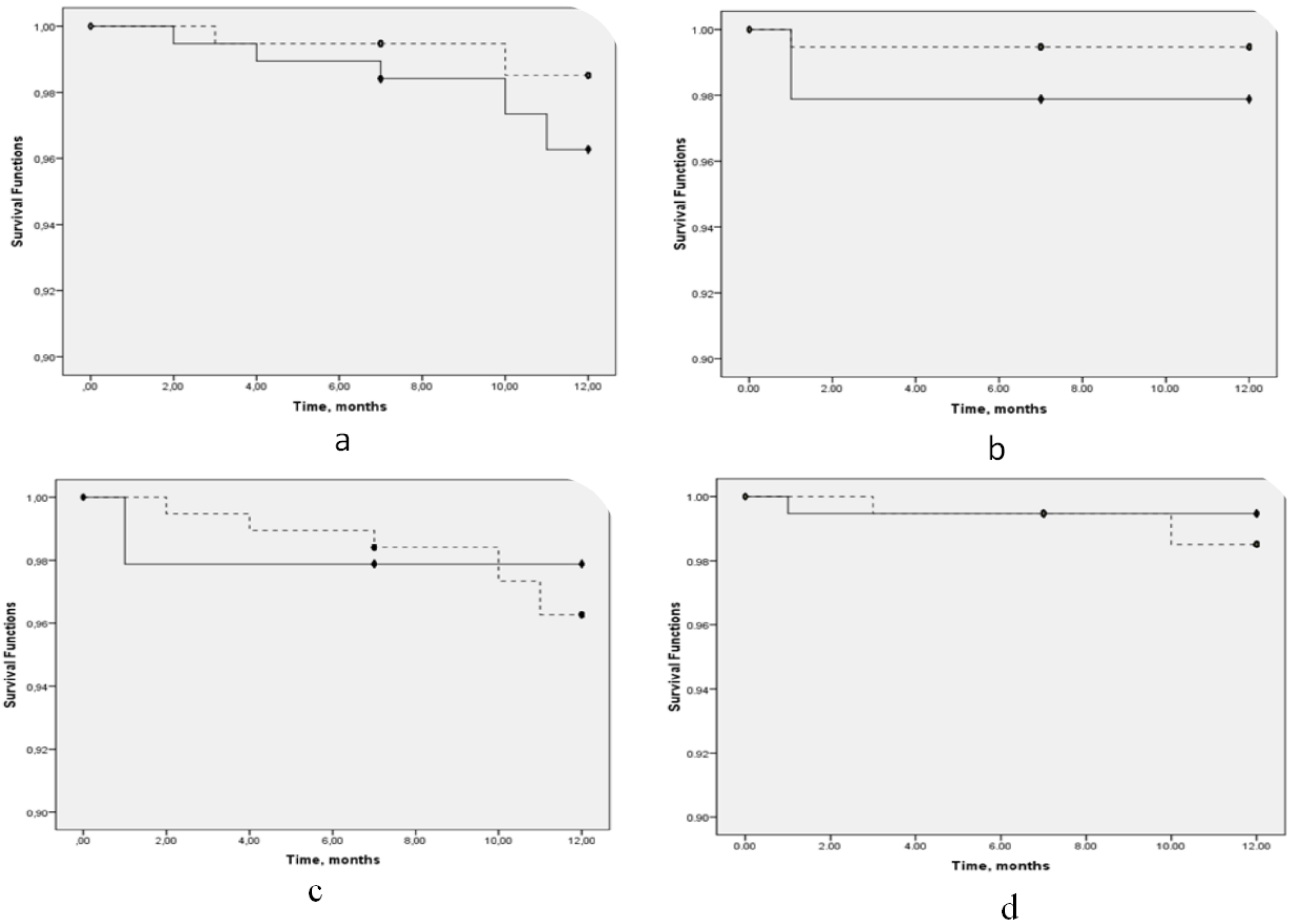

Figure 2. Kaplan–Meier survival distribution functions for **(a)** electronic ear tags placed on the mid-point (straight line) and the first-quarter part (dotted line) of the ear, for **(b)** visual ear tags placed on the mid-point (straight line) and the first-quarter part (dotted line) of the ear, for **(c)** electronic (dotted line) and visual ear tags (straight line) placed on the mid-point part (1/2) of the ear, and for **(d)** electronic (dotted line) and visual ear tags (straight line) placed on the first-quarter part (1/3) of the ear in lambs.

tronic and visual ear tag losses observed in the study were lower than those reported in the literature (Caja et al., 1999; Conill et al., 2002; Rusk, 2002; Ghirardi et al., 2006; Thomas et al., 2006).

An electronic failure was not registered during this study. Thomas et al. (2006) stated an electronic failure of 0.39 % in five types of e-ETs in ewes. In addition to losses and failures, low dynamic reading efficiency is one of the main problems for e-ETs (Huber, 2004). No reading failures in dynamic conditions with the panel reader used in the runway were recorded, which resulted in 100 % of DRE in the duration of the whole study. This value was similar to those values reported by Abecia and Palacin (2014) and Ait-Saidi (2014) for electronically identified ewes.

Three additional e-ETs were lost (1.5 %) on 197 lambs between 8 and 12 months of age, which occurred in the 10th (two tags) and the 11th (one tag) months after tagging. The increased e-ET losses could be the result of the ear tags' high weight and thick pin causing the enlargement of the ear hole. Electronic ear tag loss rates were 2.2 % (two tags) for the 1/2 part and 1.0 % (one tag) for the 1/3 part of the ear. No v-ET losses were observed during this period. The difference between the readability of e-ETs and v-ETs (98.5 and 100 %, respectively) was not significant ($P > 0.05$). However, Carne et al. (2009) found that button–button and flag–button type e-ET had a significantly higher readability (100 and 100 %) than different v-ET types (82.9 and 94.0 %) at 6–12 months of age in dairy goats.

To evaluate the performance of e-ETs and v-ETs during the 1-year period, data on 197 lambs, which were kept until the end of the study, were used (Table 1). Electronic and visual ear tags showed 98.0 and 98.0 % readability, respectively, in static conditions within the 12 months. By the end of the year, four tag losses (2.0 %) were recorded in both eartag types. Readability of e-ETs and v-ETs fulfilled the 98 %

value required by ICAR for official use at the end of the 1-year period after tagging (ICAR, 2012).

Loss rates in e-ETs and v-ETs placed on the 1/2 and 1/3 part of the ear were 3.2 % (three tags) and 1.0 % (1 tag), respectively, for both ear-tag types. No significant differences ($P > 0.05$) were observed between placement site losses. Readability of ear tags (96.8 % for e-ETs and v-ETs, 93.5 % overall) placed on the 1/2 part of the ear did not reach the ICAR value, whereas readability of ear tags placed on the 1/3 part of the ear was 99.0 % for e-ETs and v-ETs, and 98.1 % overall at 1 year after tagging as recommended by ICAR. Ghirardi et al. (2006) observed a 3.3 % annual loss in plastic ear tags in sheep. Carne et al. (2010) also reported 4.3 % of e-ETs and 3.0 % of v-ET losses at 1 year in dairy goats, which was unsatisfactory for official use according to the ICAR requirements.

Results obtained with the Kaplan–Meier nonparametric survival analyses are displayed in Fig. 2 for e-ETs (a) and v-ETs (b) based on the ear-tag placement site. When the survival distribution of e-ETs on 380 lambs between birth and 12 months of age was compared based on the ear-tag placement site, it was observed that losses of e-ETs placed on the 1/2 part of the ear occurred in the 2nd, 4th, 7th, 10th, and 11th months after tagging. On the other hand, losses of e-ETs placed on the 1/3 part of the ear were observed in the 3rd and 10th months. Thus, retention rates of e-ETs placed on the mid-point (1/2) and the first-quarter part (1/3) of the ear were estimated as 97.4 and 98.9 %, respectively, at 12 months of age by the Kaplan–Meier method.

Regarding with results of the Kaplan–Meier nonparametric survival analyses for v-ETs, it can be observed in Fig. 2b that all losses of v-ETs placed on the 1/2 and 1/3 part of the ear occurred in the first month after tagging. Four v-ETs were lost in the 1/2 part and one tag in the 1/3 part. Retention rates of v-ETs placed on the mid-point (1/2) and the first-quarter part (1/3) of the ear were estimated as 97.9 and 99.5 % at 12 months of age by the Kaplan–Meier method.

Results of Kaplan–Meier nonparametric survival analyses according to ear-tag type are displayed in Fig. 2 for the 1/2 part (c) and 1/3 part (d) of the ear. In total, five e-ETs and four v-ETs placed on the 1/2 application site were lost. Thus, retention rates of e-ETs and v-ETs placed on the mid-point (1/2) of the ear was estimated as 97.4 and 97.9 %, respectively, at 12 months of age by the Kaplan–Meier method.

As can be observed in Fig. 2d, two e-ETs and one v-ET placed on the 1/3 part of the ear were lost. Thus, retention rates of e-ETs and v-ETs placed on the first-quarter part (1/3) of the ear was estimated as 98.9 and 99.5 %, respectively, at 12 months of age by the Kaplan–Meier method. Kaplan–Meier retention values estimated from censored data were either close to or higher than the actual retention values. However, Carne et al. (2009) reported that Kaplan–Meier-estimated readabilities were generally lower than actual values for long-term retention of identification devices.

4 Conclusions

The implementation of traceability systems comprising food safety, animal health, and also animal welfare has started in Turkey. For this purpose, an electronic identification and registration system for sheep and goats has been designed in line with EU requirements. Farmers that have experience in the application of conventional ear tags are faced with adapting to the national animal identification system by also using electronic ear tags. In accordance with the requirements of the traceability system, housing conditions and fencing systems in farms should be examined and improved to reduce ear-tag losses and damage caused by snags and traps on farms, because ear tags can be easily pulled from the ear when the animal tucks its ear into fencing, feeder frames, overhangs, and other obstacles in its environment. In this study, electronic and visual ear tags demonstrated similar on-farm efficiency for the identification of Akkaraman lambs and fulfilled the minimum 98 % efficiency required by ICAR for an official animal identification device at the end of the first year after tagging. However, studies determining the effects of electronic identification devices on animal traceability should be conducted on larger numbers of animals in different rearing systems in Turkey. With regard to the placement site, it was observed that more ear tags placed on the mid-point part (1/2) of the ear were lost than the first-quarter part (1/3), but the difference was not statistically significant ($P > 0.05$). Ear tags placed on the 1/2 part of the ear were not sufficiently readable for the ICAR requirements. Based on the study findings, placement of ear tag in a cranial position and near the base of the ear would be advised. However, further research is required to confirm the influence of ear-tag placement site on loss rate.

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