However, prolonged standing on a moving vehicle is tiring, so after 12-16 hours they begin to lie down anyway. Mortality of adult cattle during transport increases with the length of the journey (Malena et al., 2007). The vast majority of cattle are bruised during loading and transport. Jarvis et al. (1995) reported bruises on 97% of the carcasses at two slaughterhouses. Hartung et al. (2007) reported significant heat stress during long road transport of cattle in the summer, especially during stops.

There have been several recent studies on the effects of long journeys on physiological and behavioural indicators of cattle welfare. Gupta et al. (2007) investigated the effect of 12 h transport by road of mature bulls that had been housed prior to transport at different space allowances (1.2, 2.7, 4.2 m^2/bull) on slatted floors for 97 days. Effects of loading bulls on a transporter, transporting for 12 h and subsequently unloading included body-weight loss, neutrophilia, eosinophilia, lymphopaenia and increased packed cell volume, red blood cell and haemoglobin levels. While transport increased cortisol and suppressed indicators of the immune response in the short-term, these changes were within normal physiological ranges, suggesting that 12 h road transport had no significant adverse effect on welfare over this period. Furthermore, transport of bulls housed at increased space allowance (4.2 m^2/bull) resulted in a greater cortisol response, albeit still within a normal physiological range. The effect of transport for up to 0, 6, 9, 12, 18 and 24 hours followed by 24 hours recovery on live weight, physiological and haematological responses of bulls was investigated by Earley and O'Riordan (2006a; 2006b). Bulls travelling for 6, 9, 12, 18 and 24 h lost 4.7, 4.5, 5.7, 6.6 and 7.5% live weight compared with the baseline. During the 24 h recovery period, live weight was restored to pre-transport levels. Lymphocyte percentages were lower and neutrophil percentages were higher in all transported animals. Blood protein and creatine kinase concentrations were higher in the bulls following transport for 18 and 24 h and returned to the baseline within 24 h. Live weight, physiological and haematological responses returned to pre-transport levels within 24 h after bulls had access to feed and water (Earley et al., 2007). These studies are based on a limited range of measurements but show that the animals studied could recover from adverse effects of transport that increase from 6-24 hours. Fatigue would increase during this time, especially if the animals could not lie down. Marahrens et al. (2003) found that bulls kept in lairage after a journey of 25-29 hours still had elevated creatine kinase 24 hours after the transport, mainly as a consequence of aggressive behaviour in the lairage. Heifers, treated in the same way, did not show aggressive behaviour but showed continuing increases in NEFA, indicating continuing attempts to recover from fatigue, in the 24 hours after transport. As reported in SCAHAW (2002), after longer journeys recovery is possible but is more prolonged and more likely to be associated with increased disease incidence.

As reported by SCAHAW (2002), if cattle are allowed to feed and drink on a vehicle, as well as rest, the space required is given by the formula $A=0.0315W^{2/3}m^2$.

Relative to many ruminants, cattle have a limited ability to concentrate urine so are particularly sensitive to water restriction. Many factors may influence the amount of water required by cattle but it depends especially on the temperature, relative humidity, development stage and production (e.g. lactation). Mature cattle drink at least every 12 hours if they can. Lactating animals drink much more often. Water requirements will increase on hot days. Mature animals normally eat several times during 24 hours and young animals eat more often CARC (2004). Many animals chose not to drink during the rest stop. However, they may have been disturbed by the conditions and body fluid concentrations may have been abnormal.

2.6. Rabbit transport

2.6.1. Fitness for transport

Reports on the welfare of rabbits in transport relate only to the transport of animals for slaughter. No data are available on the impact of transport practices on some rabbit categories (i.e. newly borne animals, lactating females, fat animals, caged and unfit rabbits). However, extrapolation from other species would indicate these categories may be more vulnerable to adverse effects related to the risk factors involved.

2.6.2. Means of transport

2.6.2.1. Provisions for all means of transport

Previous reports (EFSA, 2004a, 2004b) have indicated the size and height of the crates, type of floor, mixing unfamiliar animals, thermal stress and lack of ventilation as the most important hazard factors involved in transport stress on rabbits. New scientific evidence confirms these conclusions, and also investigates their impact in relation to other factors, such as the position of the crates within the truck (Vignola et al., 2008; Liste et al., 2008).

2.6.2.2. Additional provisions for transport in containers

2.6.3. Transport practices

Under commercial conditions, rabbits are often transported in stackable crates placed on vehicles in multi-floor crate stands with a total loading capacity ranging from 1,500 to 6,000 rabbits (TRAW, 2009). Crates can be of such a size that a person can lift one of them, or be modular units that need to be lifted with a forklift vehicle (Verga et al., 2009). In commercial situations, standard rabbit crate dimensions are as follows: 100-110×50-60×22-30 cm (length×width×height) (Verga et al., 2009).

2.6.3.1. Loading, unloading and handling

The human-animal relationship plays a key role in handling commercial rabbits, due to their shyness and diffidence towards man (Trocino and Xiccato, 2006). Rabbits that have been scared by humans, or have not been handled, try to flee and may injure themselves (Lidfors et al., 2007). Positive interactions with humans at an early stage in life could reduce their level of fearfulness. It has been shown that, in an apparent sensitive period, even minimal human contact is effective in reducing avoidance of the caretaker, and thus handling might be a useful tool to reduce stress and improve welfare even under intensive farming conditions (Csatadi et al., 2005). It has also been shown that handled rabbits approached humans significantly sooner than non-handled ones (Csatadi et al., 2007) and that frequent handling of young rabbits not only changes their behaviour in terms of reducing fear of humans but also positively influences the growth rate and reduces the mortality rate (Jezierski and Konecka, 1996).

Handling and the method of loading can affect carcass quality. Rabbit loading is commonly carried out in one of two ways: individually loading rabbits in transport containers filled on the farms, or collecting and placing, even throwing, animals into containers fixed on a truck. Rabbits on the upper truck levels are often subjected to a greater number of falls than on lower levels (TRAW, 2009). The type of floor for transport crates is still debated. Under housing conditions, growing rabbits prefer a plastic net floor to a wire mesh floor (Princz et al., 2007). Plastic has low thermal conductivity, therefore it may give a sensation of warmth so rabbits prefer staying on plastic (rabbits choose plastic floors if they can). In addition, plastic could reduce footpad injuries, although rabbits could chew plastic floors (TRAW, 2009). However, solid floors may impede ventilation and are more difficult to wash at the abattoir after slaughtering compared with those made of wire (Verga et al., 2009).

The effects of the loading method and crate position on the trucks on some stress indicators in commercial rabbits transported to the slaughterhouse were studied (Vignola et al., 2008). In July, a total of 192 animals were transported on 100 min journeys to the slaughterhouse. Animals were equally distributed at random in top front (TF) and bottom front (BF) crates, and top rear (TR) and bottom rear (BR) crates in order to evaluate the effects of crate position. Rabbits were loaded either in a smooth way (taken from the farm crates, placed in a wide trolley and carried gently into the transport cage) or in a rough way (rabbits from four crates were carried all together in the same trolley and loaded hurriedly). The TR crates showed the highest mean temperature and the lowest relative humidity while the other cages on the truck differed only in humidity. Rabbits transported in TR crates showed a significant increase of total protein level, as a possible consequence of dehydration. Loading methods or crate position in the truck did not significantly affect weight losses during transport. Corticosterone significantly increased only during transport using the rough loading method. Neutrophilia and lymphocytopaenia were significant for all rabbits, independent of the treatment received. No differences in PCV were found among groups. Aspartate transaminase (AST) and CK activities significantly increased in all the animals.

Rough rabbit handling has been reported to increase pre-slaughter mortality and main carcass defects, such as haemorrhages, bruises and broken bones (Verga et al., 2009). Mazzone et al. (2010) investigated the impact of handling during loading on rabbit meat quality. A total of 192 rabbits were loaded onto the truck smoothly (each subject carefully placed into the transport crate) and 192 rabbits were loaded roughly (loading was hurried and carelessly executed by the transport operator, throwing each animal into the crates fixed on the truck) and then transported (100 minutes, 12 animal per cage, 57.7 kg/m^2) to the abattoir. Transport, independently of loading method, significantly increased neutrophilia, lymphocytopaenia, serum AST, alanine transaminase (ALT) and CK activities, and serum corticosterone concentration. PCV after transport did not differ from values detected at the farm, in agreement with Liste et al. (2008), who did not find any variation of PCV in commercial rabbits transported to the abattoir. No adverse effects of loading method on carcass traits and meat quality were highlighted. On the basis of these findings, Vignola et al. (2008) and Mazzone et al. (2010) concluded that the stress parameters analysed were more influenced by transport (including handling) rather than by the different loading methods or crate position in the truck. Liste et al. (2006) also found that different loading methods did not exert significant differences on the stress indicators. They concluded that, in order to have an effect on meat quality, the threshold for stress was probably higher than the threshold needed to have an effect on welfare indicators.

Buil et al. (2004), in a survey of Spanish rabbit abattoirs, found that handling procedures differed widely among farms, especially regarding cage size (ranging from 1,430 cm² to 10,000 cm²). Loading facilities were adequate but only a few haulers had received specific training courses. All the farms used a cage system for transport, and 68% of the cages were of a medium sized type (from 0.35 m^2 to 0.5 m^2), with an animal density of 349.2 ± 83 cm^2/rabbit. The mean height of the cages was 30.7 ± 9.3 cm. Average time before unloading was short (4.5 ± 13.8 minutes) but lairage time before slaughter was usually longer than one hour and varied widely between abattoirs (ranging from 0 to 420 minutes). Loading time ranged from 10 to 240 minutes, but the most frequent was 90 minutes (33%). Animals were normally unloaded in the morning (55%) and this procedure lasted an average of 23 ± 15 min. Nearly all the abattoirs (85%) unloaded the cages in groups or cage stands. The unloading point was covered and protected from the wind in about 80% of the abattoirs. The holding area was also covered and half of the areas surveyed had an air ventilation system.

2.6.3.2. Facilities and procedures

It is well known that transport involves several potentially stressful factors: climatic factors such as temperature or humidity; physical factors such as noise and vibration; and emotional factors such as unfamiliar environment or social regrouping. The effects of four potential transport-related stressors (heat [HS], cold [CS], noise [NS] and mixing with unfamiliar animals [MS]) on certain physiological and meat quality parameters of rabbits were studied (de la Fuente et al., 2007). The rabbits were exposed to each potential stressor for 4.5 h prior to slaughter. HS groups showed the highest plasma concentrations of cortisol, lactate and glucose and greater PCV and osmolarity, and the meat exhibited a low initial pH following lactic acid accumulation (de la Fuente et al., 2007). The high plasma lactate concentration in HS rabbits could be due to an accumulation of lactic acid induced by excessive panting. Panting is an inefficient mode of heat loss when the environmental temperature is in excess of 30 ºC and, if it is prolonged, a metabolic alkalosis can occur due to CO_2 deficit (Fayez et al., 1994). CS and NS exposed rabbits also showed physiological responses to the potential stressor, although to a lesser degree than rabbits exposed to HS (de la Fuente et al., 2007). Cold stressed rabbits showed increased levels of CK and a higher PCV, as well as decreased muscle glycogen concentration. NS exposed rabbits showed muscular damage, as demonstrated by increased CK and LDH activities in the blood and a high final pH in meat. Mixing unfamiliar rabbits (MS) led to higher CK activity, lower lactate and glucose concentration and a slight increase of the meat pH. In summary, rabbits exposed to heat were the most affected of all three groups, although cold, noise and mixing with unfamiliar rabbits also had a detrimental effect on physiological and meat quality parameters (de la Fuente et al., 2007).

2.6.4. Water and feeding interval, journey times and resting periods

Water and food withdrawal – Lairage

In most commercial abattoirs rabbits are unloaded from the lorry and kept in their crates in a protected area to await slaughter. Thus lairage represents an additional period of deprivation of water and/or food. Usually, this area is placed outside, and very few abattoirs provide an enclosed area equipped with forced ventilation and water-misting sprays as a control strategy for adverse environmental conditions (Verga et al., 2009). In a survey of Spanish rabbit abattoirs (Buil et al., 2004), it was found that, before slaughter, there is a short lairage time where animals are kept in the same multi-floor transport cages in a holding area near the stunning facilities. About 80% of the abattoirs surveyed used multi-floor cages during this period with an average capacity at the holding area for 250 (range 45 to 1,500). Only one abattoir used specific lairage cages for the rabbits in the hold area (i.e., rabbits were transferred from the transport cage to a lairage cage). The average waiting time before slaughter was 110 ± 113 min (range 0 to 420 minutes). Only one abattoir had facilities to provide food and water to the animals under long holding periods (Buil et al., 2004).

There is much evidence that antemortem harvesting, transport and lairage of rabbits at the abattoir are stressful, as indicated by physiological and biochemical changes occurring during these phases (de la Fuente et al., 2004; María et al., 2006; Liste et al., 2006). However, it has also been suggested that lairaging rabbits at abattoirs under favourable conditions may lessen the effect of transportation on animal welfare and meat quality properties (Cavani and Petracci 2004; María et al., 2006). A study was conducted to determine the effects of journey duration (1 versus 3 h) and lairage time at the abattoir (0 versus 5 h) on rabbit meat quality traits (Petracci et al., 2009). Rabbits transported for 3 h produced meat with significantly higher pH values, which was darker and had less yellow colour, as well as lower losses during cooking, than those transported for 1 h. Moreover, animals laired for 5 h yielded meat with more yellow colour, cooking losses and higher shear values than rabbits not laired before slaughtering, revealing that lairaging before slaughter at the abattoir can only partially contribute to lessening the effect of transportation on rabbit meat quality properties (Petracci et al., 2009).

Liste et al. (2009) studied the effects of duration of lairage time before slaughtering (2 v. 8 h) and position in a multi-floor cage rolling stand (MFRS) truck, on welfare and on instrumental and sensorial meat quality of hybrid commercial rabbits. Stocking density in the truck during lairage was 360 cm^2/animal. Lairage time and position on the MFRS had significant effects on blood stress indicators (haematocrit, glucose, lactate, CPK and corticosterone). On the other hand, lairage time only had a slight effect on meat quality traits (pH24, water holding capacity (WHC), colour, raw and cooked texture, sensory quality). The extent of haematomas (bruising) on the carcass was significantly higher in the short lairage group (0.82% ± 0.11) than in the long lairage group (0.48% ± 0.11). This higher incidence of bruising may have been due to contusions or gripping produced during pre-slaughter handling of more stressed and, consequently, more reactive rabbits (Liste et al., 2009). Lairage duration of 6–8 hours was recommended as an adaptation period required before slaughter to allow animals to recover from the stress of transport and, presumably, improve meat quality (Liste et al., 2009).

The level of stress required to decrease meat quality substantially is greater than the level required to affect plasma stress indicators. On this basis, the lack of an effect on meat quality does not necessarily imply that animal welfare is optimal during the slaughter process. Slight negative effects on rabbit meat quality probably are an indicator of serious welfare problems during pre-slaughter handling, including lairage (Liste et al., 2009). These conclusions contrast with findings of a survey on the effect of pre-slaughter conditions on commercial rabbits, in which short lairage (<150 minutes) was less compromising for welfare than medium and long lairage (150-240 minutes and >240 minutes, respectively; Petracci et al., 2008).

Preslaughter conditions have been shown to affect mortality rate, live weight loss, carcass yield and quality grades, especially the proportion of carcasses downgraded because of quality defects (Cavani and Petracci, 2004). Petracci et al. (2008) conducted a survey on 831 herds of rabbits in a commercial chain to determine the effect of the season, journey (short: <220 minutes; medium: 220-320 minutes; long: >320 minutes) and lairage (short, medium, long, from 150 up to >250 minutes) on mortality, live weight loss, slaughter yield and carcass quality. The overall average mortality rate and live weight loss were found to be 0.082% and 3.39%, respectively. Herds subjected to short lairage exhibited a significantly lower mortality rate (0.065% vs. 0.075% vs. 0.105%) and higher carcass yield (57.8% vs 57.4% vs 57.1%) when compared with medium and long lairage times. As for carcass evaluation, overall average incidence of downgraded and condemned carcasses was 0.40% and 0.46%, respectively, while the bruised carcass level was 2.22%. In a previous study by Cavani and Petracci (2004), the authors found that the areas most frequently bruised were the legs, thoracic muscles and the internal part of the loin region. These bruises were mostly not detectable in the live rabbit and only become visible when the skin was removed after slaughter. Petracci et al. (2008) concluded that lairage time was one of the main critical points affecting mortality rate, slaughtering yields and carcass quality.

Fasting time during transport is important because it affects animal welfare, but it also affects carcass yield (live weight losses), carcass contamination, and product safety and quality (Verga et al., 2009). Cavani and Petracci (2004) determined that rabbits lose 3-6% of body weight during the first 12 hours of fasting, which increases to about 8-12% at 36-48 hours. According to Lambertini et al. (2006), weight loss recorded in the first 4-6 hours in transported rabbits with food removal is mainly due to emptying of the gut, so carcass yield is not negatively influenced. For longer periods (after 6 hours fasting), Trocino et al. (2003) found that there was also a loss in moisture and nutrients from body tissues, which can impair carcass yield. De la Fuente et al. (2004) found that rabbits exposed to both fasting and transport lost more live weight compared with those that merely fasted, although in a later study (de la Fuente et al., 2007) involving animals fasted for 4.5 hours, no significant differences in live weight losses were seen between all four treatments.

In conclusion, the critical points during the transport process that emerged from a survey performed in Spain (Buil et al., 2004) were waiting time at the farm before loading, loading, ventilation and temperature during transport (cage position), loading stops, unloading, holding time before slaughter, environmental conditions during holding and time between stunning and bleeding. Another critical aspect was that many slaughterhouses took the rabbits to be slaughtered directly from the transport cage tower. Towers are moved from the waiting area and located very close to the stunning point, so most rabbits can see, hear and smell the animals which are slaughtered at a close distance. This point could represent an additional stressor to the rabbits because there is some evidence that animals can smell pheromones associated with the slaughter stress, which could increase fear before slaughter (Buil et al., 2004). Furthermore, fear and distress could be communicated among rabbits kept in the same room (Beynen, 1992).

This new scientific evidence does not confirm that “rabbits can reasonably withstand food and water deprivation for 24 hours without significant adverse effects on bodyweight and carcass quality” as previously stated (EFSA, 2004).

Journey time - position on the truck

It is well known that rabbit transport is characterised by multiple collection points, which implies that animals may wait for an indeterminate time in the containers either at the farms, on the means of transport and at the slaughterhouse holding area (Buil et al., 2004). In addition, at present, long journeys are increasing because of the reducing numbers of rabbit abattoirs (Buil et al., 2004).

In Italy, commercial rabbits are usually transported to the abattoir using a commercial lorry, which has two or three axles and a loading capacity ranging from 1,500 to 6,000 rabbits (Verga et al., 2009). In a recent survey conducted in Spain, the average transport time was 154 minutes (range: 20 to 600 minutes) corresponding to 137.5 km (range: 25 to 500 km) (Buil et al., 2004). Similar journey durations were also registered in Italy (Petracci et al., 2008). In the survey conducted by Petracci et al., (2008), short journeys (<220 minutes) exhibited lower mortality rate compared to medium (220-320 minutes) and long journeys (>320 minutes) (0.053% vs. 0.080% vs. 0.113%, respectively), as well as lower live weight loss (2.43% vs. 3.47% vs. 4.26%), and higher slaughter yield (58.0% vs. 57.3% vs. 57.0%). Long journeys also showed a higher incidence of bruised carcasses, but did not influence downgraded and condemned carcass rates. In conclusion, long journeys, in addition to lairage, were shown by the survey to be the main critical points, and these impaired the mortality rate, slaughtering yields and carcass quality (Petracci et al., 2008).

Lambertini et al. (2006) assessed the impact of transport time (1, 2 and 4 hours) on commercial rabbits. They found that live weight losses increased from 1.6 to 3.3% following journeys that lasted 1–4 hours, but they were about 2% when rabbits were transported for 2 hours. Live weight loss was caused by urine and faecal losses but also by a reduction of carcass weight during transport. In addition, higher pH values (6.01) and lower pH decreases were reported when rabbits were subjected to longer journeys (4 hours) compared with the 2 hour ones. In addition, the longest journeys were associated with a more purple-red meat, darker, and firmer when raw, and less cooking loss compared with the shortest journeys.

The effect of journey duration, position on the truck and high temperature on some physiological indicators of stress and meat quality in commercial rabbits has been investigated (Liste et al., 2006). In the summer, 78 rabbits were subjected to either long (7 hours) or short (1 hour) journeys to the abattoir. There was a trend for the levels of corticosterone, glucose, lactate, and CK to be slightly higher after long journeys compared with short journeys, but the differences were not significant. Short and long journeys did not affect pH24 and WHC values, whereas journey time had a significant effect on meat tenderness and compression values (measurements of the tenderness of raw meat).

The effect of transport time (1 hour vs. 7 hours) on the stress response of rabbits was further studied in relation to season (summer and winter) and the position on the truck (top, middle and bottom layers; Liste et al., 2006, 2008, 2009). Corticosterone and CK levels were highest after 1 hour transport compared with 7 hours. However, pH24, which is considered one of the main parameters of welfare measurements, was not affected by transport time or position on the truck. The pH24 values were within normal ranges for all treatments but slightly higher for animals transported in winter. Position on the truck, in particular the lower one, also affected the physiological response to stress in rabbits. Corticosterone concentrations were highest on the bottom layer, and lowest on the top. Rabbits on the bottom and middle layers had significantly higher levels of CK and lactate, indicative of higher muscular activity. On the contrary, position on the truck did not influence the measurements of meat quality (Liste et al., 2008).

In a similar study (María et al., 2008), position on the truck did not affect measurements of meat quality, both in relation to journey time and seasons. Conversely, journey time had a significant effect on meat texture parameters, as measured by compression, but did not affect average pH24, WHC, shear force or toughness. In general, transport time had much less of an effect on meat quality compared with season, and higher responses were recorded in summer than in winter.

Season and thermal stress

Exposure to high ambient temperature induces rabbits to try to balance the excessive heat load by using different means to dissipate, as much as possible, their latent heat. Optimal climatic conditions for rabbits would be: air temperature 13 to 20 ºC (average 15 ºC), relative humidity 55 to 65% (average 60%) (Marai and Rashwan, 2004). Adult rabbits exposed to ambient temperatures below 10 ºC curl up to minimise their total body surface area exposed and lower their ear temperature, and the ear pinnae are folded to avoid internal surface contact with air. At the same time, they drag the ear to bring it closer to the body (Marai and Rashwan, 2004). Since rabbits do not sweat, at temperatures above 25-30 ºC they stretch out to lose as much heat as possible by radiation and convection, raise their ear temperature, stretch the ear pinnae and spread them far from the body to expose the surface to the surroundings in order to increase heat dissipation. Above 35 ºC, rabbits can no longer regulate their internal temperature and heat prostration sets in, while at 40 ºC, considerable panting and salivation have been shown to occur (Lebas et al., 1986 in Marai and Rashwan, 2004). The average lethal ambient temperature is 42.8 ºC. The comfort limits for rabbits (Marai et al., 2002) are defined as: temperature-humidity index (THI)<27.8 ºC, absence of heat stress; 27.8 to 28.9 ºC, moderate heat stress; 28.9 to 30 ºC, severe heat stress; THI>30 ºC, very severe heat stress.

Although thermal stress is a crucial factor in transport stress in rabbits, few studies have focused on this research area. Recently, Liste et al. (2006) found that, in the presence of high temperatures, the position on the transport truck had a greater influence on rabbit welfare than the duration of the journey. In another study (Liste et al., 2008), it was observed that winter temperatures increased corticosterone, while summer temperatures increased CK.

The season proved to have a significant effect on pH24, WHC, all colour parameters, shear force and toughness (María et al., 2008). In general, season had a greater impact on meat quality parameters compared with journey time, with higher impacts recorded in summer than in winter. These findings are in contrast to those obtained in the survey of Petracci et al. (2008). During winter, lower live weight losses (3.12%) were recorded, whereas carcass yield (57.9%) was higher during summer. Carcass bruising had a higher incidence during summer in respect to other seasons, while downgraded carcass prevalence was higher in autumn. Petracci et al. (2008) concluded that season played only a minor role, probably due to the fact that transport was mainly conducted during the night and early morning, thereby moderating the effect of high summer temperatures.

De la Fuente et al. (2004) has demonstrated that some rabbits may experience heat stress during transport in summer. This included signs of severe heat distress, elevated blood cortisol, lactate and glucose, CK and LDH, and greater dehydration and osmolarity. The same authors observed that winter transport increased muscle activity, as evidenced by the lower liver and muscle glycogen concentration. This implies some degree of cold stress. Mazzone et al. (2009) investigated the effect of microclimatic conditions within the vehicle on the welfare of rabbits during transport to the slaughterhouse. The top rear position on the truck was characterised by the highest T°C and, particularly in summer, by the lowest relative humidity. In winter, BF showed the lowest T°C and the highest relative humidity. However, these differences in microclimate had no effect on stress parameters, although rabbits transported in summer were more stressed than in winter (Mazzone et al., 2009).

In a survey of Spanish rabbit transport procedures (Buil et al., 2004), it was found that the roof and walls of the trucks were made of different materials, but normally aluminium (23.8%) and steel (14.3%). Only half of the trucks had an insulated roof and in 76.2% of the lorries the environmental conditions during transport were not controlled, and they lacked artificial light, mechanical ventilation or temperature control.

2.6.5. Space allowances (transport by rail, by road, by air, by sea, densities)

Commercial rabbits marketed for slaughter are generally transported in crates. Swallow et al. (2005) suggested a minimum stocking density for transporting laboratory rabbits in filtered crates ranging from 0.2 m^2 to 0.16 m^2 for rabbits weighing more than 1 kg and, in unfiltered crates, ranging from 0.1

m^2 to 0.08 m^2 for rabbits weighing more than 2.5 kg. Swallow et al. (2005) also suggested that container height should be restricted for laboratory rabbits to prevent back injury caused by kicking out. However, since rabbits do not sweat, at environmentally high temperatures space is needed to allow rabbits to assume appropriate postures, such as sitting up or lying flat with ears extended in both of these positions to expose the surface to the surroundings in order to increase heat dissipation (Marai and Rashwan, 2004). In addition, rabbits tend to sit upright as a control "security and safety" behaviour (Lidfors et al., 2007).

In practice, crate dimensions for transporting commercial rabbits can vary. Standard measurements are reported to be 100-110×50-60×22-30 cm (length×width×height) (Verga et al., 2009). The number of rabbits loaded into crates also varies according to animal weight and environmental conditions: 14-16 animals/crate for rabbits weighing 2.0-2.7 kg and 12-14 animals/crate for rabbits weighing 2.8-3.2 kg, resulting in a commercial stocking density varying from 0.03 to 0.05 m^2/rabbit (Verga et al., 2009).

Notwithstanding these indications, little new scientific information has been added to previous knowledge. Lambertini et al. (2006) investigated the effect of journey time (1, 2 or 4 hours) and stocking density (high and low, 75.5 or 49.0 kg/m^2, respectively) during transport on carcass and meat quality of 450 rabbits (75.5 kg/m^2 is that normally used when transferring rabbits from the farm to the slaughterhouse in Italy). These authors found that longer journeys significantly reduced live weight, whereas there were no significant effects of animal density in the transport cages on weight losses and slaughter data, and there was also no significant interaction between transport time and stocking density (Lambertini et al., 2006). These findings are consistent with those previously obtained by de la Fuente et al. (2004) who worked with even lower densities (high and low, 53.6 or 37.0 kg/m^2, respectively) comparing summer and winter journeys. These authors found that season significantly influenced the loss of live weight during transport, with lower live weight loss in rabbits transported in summer than in winter. Plasma concentrations of cortisol, lactate and glucose, CK and LDH activity, and osmolarity, as well as liver and muscle glycogen concentrations were higher in rabbits transported in summer than in winter, suggesting that the welfare of the rabbits was more at risk during transport in hot weather. Stocking density had no effect on the analysed parameters. The authors hypothesised that the lack of differences between the two stocking densities may have been because differences between them were insufficient to improve rabbit welfare, suggesting that other factors, such as the height of the cage or the number of layers might be more significant (de la Fuente et al., 2004).

2.7. Poultry transport

In order to find relevant published information in agreement with the Terms of Reference of the mandate, a bibliographic search was performed. For the search, a list of search key words was created (i.e. poultry, chicken, broiler, hen, chick, transport, stress, welfare, journey, regulation, legislation) and the year of publication was set up to be after 2004. After the collection of information and data from electronic sources, publications were accepted or not according to previously established criteria. After the first screening, a total of 199 references were obtained dealing exclusively with the welfare aspects of the transport of all relevant species. From these, 94 references passed the screening process according to the acceptance criteria and were used for the development of the following section of the Scientific Opinion (search protocols undertaken in accordance with EFSA, 2010b).

The current section is focused upon chickens, although the principles, conclusions and recommendations may be pertinent to the transportation of turkeys, ducks, guinea fowls and other game birds.

It is necessary to examine the transportation of poultry in terms of the primary species involved in commercial production and to include due consideration of the ages or stages of development at which birds may be transported. Thus, the main categories may be considered to be: