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The effects of artificial rearing and fostering on the growth, carcass and meat quality of lambs

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ABSTRACT

Lamb rearing is a key point to ensure good quality at the end of the production cycle. Fostering and artificial rearing are techniques commonly used when natural rearing is compromised. However, there is a lack of research investigating their impact on the product's quality, especially when lambs are slaughtered late, around 6 months of age. The current study investigated the effects of artificially reared and fostered lambs on growth, carcass and meat quality. The three foster methods under study were birth fluids, cervical stimulation combined with birth fluids and restraint. Animals were weaned at 3 months of age, and processed at 6 months of age. Artificially reared lambs presented lower weight gains than ewe reared ones at young ages. They also presented worse conformation scores at the processing plant. No differences could be found for growth rates, carcass or meat quality among the foster methods tested.

1. Introduction

In 2013, the worldís production of sheep meat surpassed 8.589 million tonnes, with Europe producing around 1.130 million tonnes (FAOSTATS, 2016). In the specific case of the English lamb industry, it has been estimated that only 54% of lambs reach acceptable market requirements (EBLEX, 2007). Subsequently, if the UK produces around 289,000 t of sheep meat per year (FAOSTATS, 2016) this could theoretically indicate that a large amount of meat could be potentially wasted because of lambs not reaching acceptable market requirements. An important aspect to ensure that lambs reach an acceptable market standard is the proper care from birth and appropriate use of husbandry techniques (Diaz et al., 2002; Chestnutt, 1994). A key step during lamb rearing is weaning, and its effects (early vs. late) on carcass and meat quality have been widely studied (Cañeque et al., 2000; Napolitano et al., 2002; Norouzian and Valizadeh, 2011; Ekiz et al., 2012). In general, late weaning is associated with better growth rates and conformation scores but regarding meat quality no significant effects have been usually reported. These effects on growth and carcass quality are traditionally linked to the physiological changes needed to switch from a liquid to a solid food source and its repercussions in overall intake (Cañeque et al., 2000). There is also extensive literature on the effects that artificial vs. maternal rearing has on lambs at weaning (Napolitano et al., 2006; Norouzian and Valizadeh, 2011). Most studies conclude suggesting that initial weight differences at weaning can be found, but with no lasting effects on carcass characteristics at time of slaughter. Some other studies though (Lanza et al., 2006; Vicenti et al., 2004) have reported significant differences on carcass weight, meat colour and fat contents with lambs fed on ewe milk being heavier, with lighter meat colour and lower fat content. Conversely, Napolitano et al. (2002) reported that the artificially-reared lambs produced better quality meat than lambs receiving ewe milk (significantly higher carcass yield percentage, second grade cut percentage and significantly less leg fat percentage). Fostering is a rearing technique commonly used within the lamb industry worldwide. However, there is a lack of research investigating its impact on the quality of the resulting products, especially in production systems where lambs are slaughtered late, around 140–180 days old, such as the UK industry.

The current study investigated the differences between artificially reared (AR) and fostered lambs on growth and live morphometric indices, carcass quality and meat quality. The three foster methods under study were birth fluids (BF), cervical stimulation combined with birth fluids (CSBF) and restraint (R). The present paper was part of a larger study investigating the effects of different foster methods on the welfare of ewes, where R ewes

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presented higher cortisol levels and lowered maternal behaviours representing compromised welfare (Ward et al. in preparation). These rearing treatments were compared to control ewes raising their own twins in a commercial setting where lambs were weaned at 3 months but kept grazing until slaughter at 6 months of age. If differences were still present among treatments at the time of slaughter this could mean long-term implications of distress early in life, implications that could not be resolved by a long compensatory post-weaning period. If foster methods such as R, detrimental to ewe welfare as mentioned above, were to affect lamb performance as well, they should be considered not suitable and their use discouraged.

2. Materials and methods

2.1. Animals

Moulton College Sheep Farm (Northampton, UK) is home to approximately 1000 North Country mule ewes. 84 ewes in total were monitored during two lambing seasons (spring 2009 and 2010) for the current experiment. Experimental ewes were multiparous ($n = 48$) or primiparous ($n = 36$). A total of 180 North Country mule lambs, of both genders (97 females and 83 males), classified as natal (raised by their own mother), alien (fostered) or AR (bottle fed) were included in the current experiment.

2.2. Housing and husbandry

Ewes were naturally mated and grazed outdoors until approximately four weeks prior to lambing. They were then housed together in large covered sheds according to their pregnancy scan results, creating three groups: singles, twins or triplets. At lambing, ewes were left on their own unless difficulties arose, in which case an experienced shepherd aided delivery. Each ewe and its lamb/s were relocated to an individual pen (1.52 m × 1.14 m) within four hours from delivery time, where interference from other ewes was avoided and maternal bonds could be better established. After four hours in the individual pen, the lambs were routinely checked and treated (ear tagging and treatment of the navels and watery mouth). The fostered and AR lambs were selected from ewes giving birth to triplets. A triplet was allocated a foster dam from the group giving birth to single lambs and housed in an individual pen; the fostering method was then applied choosing among the three treatments to be tested (see Table 1). For the R treatment, special restraint pens measuring 1.20 m × 1.10 m were used.

2.3. Treatments

Foster was performed immediately after the single-bearing ewe delivered her lamb, if any recent triplets were available. Weights at birth and lamb gender were allocated to try and create the most homogeneous treatment groups possible, but as the work was carried out in commercial facilities these confounding effects could not be completely balanced. The treatment groups were classified as birth fluids foster (BF, N = 48 lambs); cervical stimulation combined with birth fluids foster (CSBF, N = 24 lambs), restrained foster (R, N = 48 lambs), AR lambs (N = 12 lambs) and the control group (N = 48 lambs). Only successful fosters were included in the study, as the purpose was to investigate the long term implications of different fostering techniques. BF treatment (from 12 primiparous and 12 multiparous ewes, 48 lambs in total) consisted in coating the alien lamb with the birth fluids from the single lamb-bearing fostering ewe. CSBF treatment (from 12 multiparous ewes only, 24 lambs in total) involved the shepherd gently pushing his hand into the cervix of the single-lamb bearing fostering ewe and simulating contractions by opening and closing the hand at ten seconds intervals. Then the shepherd coated the alien lamb using the foster ewe' birth fluids. Due to the fragile nature of primiparous ewes CSBF was not performed on them. R treatment (from 12 primiparous and 12 multiparous ewes, 48 lambs in total), was conducted in specific pens where the ewes heads were locked outside by the neck between vertical bars. The lambs were then placed inside the pen, behind the ewe's head. The restraint pens enable the ewes to lie down, stand and have access to food and water. However they inhibit its ability to look and sniff at the lambs. The ewes were left in the restraint pens for a maximum of 5 days, depending on their level of acceptance of the lamb and the lambs' ability to successfully feed. These three fostering methods were selected for the experiment because it was previously found that they were the most commonly used by UK farmers (Ward et al., 2011). A random sample of 24 ewes (12 primiparous and 12 multiparous, 48 lambs in total) were selected from the group of ewes scanned as twins and used as controls. AR lambs ($n = 12$) were placed in a lambing pen provided with a heat lamp and were initially force fed natural cow colostrum sourced from the Moulton College dairy unit using a stomach tube. Subsequent feedings took place every three hours with warm artificial milk powder (*Lamb Force ewe milk* replacer, Downland®; Carlisle, UK) mixed at 20 g of milk powder for 250 ml of warm water. Each lamb was fed from individual bottles at a rate of 50 ml per kg of body weight. This milk powder contained 23% oils, 23% protein and 8% ash, and it was enriched with vitamins A, D_3, E and Selenium. Bottle feeding occurred individually, with three persons (two stockpersons and one researcher) taking turns to bottle feed the 12 AR lambs every three hours for their first 2 weeks of life (during the lambing season). The authors acknowledge that this technique is potentially less adequate to feed AR lambs than *ad libitum* feeding through automatic equipment, but it is still a common occurrence in small to medium UK farms and thus valid to be studied. These lambs were weaned (all milk supplements removed) at 3 months of age as the other experimental lambs.

After three days, experimental ewes and lambs were identified with spray markers and relocated into group mothering pens of approximately 400 m^2. These pens were also covered areas within the lambing sheds which housed up to 10 ewes and their lambs. When lambs were at least one week old, ewes and lambs were taken to the surrounding fields remaining in outdoor grass pastures with supplementary feeding of lamb creep pellets. At around three months of age, all experimental lambs were weaned, and kept grazing in the same fields without their dams until approximately six months of age when they were sent to slaughter. The trial was approved by the ethical committee at Moulton College and the University of Northampton and followed the ARRIVE guidelines where necessary. As the animals were not subjected to stressful manipulations other than those included in routine farm rearing, no other licenses or permits were needed for the study.

2.4. Data collection

2.4.1. Pre-slaughter data

All lambs were weighed and measured on their date of birth (day 0) and then on days 7, 30, 90 and 180. These days were chosen as coincident with relevant husbandry procedures. Day 7 referred to the weight/measures before the lambs were put out to pasture. Day 30 coincided with the routine medication for the lambs (fly-strike and prophylactic endoparasitic treatment). Day 90 represented weight/measures at weaning. Finally, day 180 corresponded to weight/measures of the finished lambs, on the day prior to slaughter. Weights were taken using a digital spring balance (Portable Electronic Scale, OCS-1, London, UK) with the lambs placed in a bucket until they reached 20 kg (30 days of age). Salter Brecknell® LS300 (Brecknell®, West Midlands, UK) weighting scales were used for 90 and 180 day weights. Daily weight gain