PROVA ESTRATTA

ISTITUTO ZOOPROFILATTICO SPERIMENTALE
DELLA LOMBARDIA E DELL'EMILIA ROMAGNA
"BRUNO UBERTINI"
(ENTE SANITARIO DI DIRITTO PUBBLICO)

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9 maggio 2025 ore 9:30

PROVA N° 1

1) Cenni di condizioni microclimatiche degli allevamenti: esempi di parametri da valutare

2) Significato e ruolo del Centro di Referenza Nazionale per il Benessere Animale (CReNBA)

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 2

1) Come si valutano le lesioni cutanee nella bovina da latte per eseguire una valutazione del Benessere Animale?

2) Significato e contenuti di Classyfarm

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9 maggio 2025 ore 9:30

PROVA N° 3

1) Quali sono le ABMS dirette nel bovino da carne?

2) Il candidato riporti alcuni esempi di normativa verticale in tema di biosicurezza negli allevamenti

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9 maggio 2025 ore 9:30

PROVA N° 6

1) Come si suddividono le procedure di biosicurezza e che scopo hanno?

2) Esempi di animal based measures (ABMs) indirette

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 10

1) Che differenze ci sono tra il controllo ufficiale e l'autocontrollo in termini di valutazione del benessere animale?

2) Quali sono i settori dell'allevamento suino in cui il consumo di farmaco è più elevato?

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 11

1) Significato della dogana danese nelle misure di biosicurezza
2) Come si valuta la pulizia del mantello negli animali da reddito

Prova estratta

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9 maggio 2025 ore 9:30

PROVA N° 12

1) Quali sono i settori dell'allevamento bovino in cui il consumo di farmaco è più elevato?

2) Concetto di significatività statistica

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 13

1) Conosci alcune definizioni di benessere animale

2) Esempi di test statistici

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 15

1) Tipologie di allevamento ovino e caprino

2) Nel Benessere Animale cosa sono le misure resource based?

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 16

1) Esempi di normative verticali per il benessere animale

2) Come puoi misurare lo stato di nutrizione di un animale?

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 17

1) Cenni di una corretta colostratura nel vitello da latte

2) Esempi di mutilazioni consentite negli animali da reddito

PROVA ESTRAPI. 5

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9 maggio 2025 ore 9:30

PROVA N° 18

1) Caratteristiche degli abbeveratoi in una stalla da latte

2) Cos' è un antibiogramma e a cosa serve?

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 19

1) Cause di riforma nei bovini
2) Il candidato esponga quali indicatori di benessere animale possono essere raccolti al macello

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9 maggio 2025 ore 9:30

PROVA N° 20

1) Cos'è l'antimicrobico-resistenza e perché è importante contrastarne il fenomeno

2) Parlami della morsicatura della coda nel suino

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 21

1) Divisione di una mandria di bovine da latte in un allevamento intensivo

2) Differenze tra allevamenti intesivi ed estensivi e concetti di biosicurezza applicati alle due realtà

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9 maggio 2025 ore 9:30

PROVA N° 22

1) Tipologie di allevamento suino
2) Esempi di strumenti da applicarsi alla precision livestock farming (PLF)

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 24

1) Tipologie di allevamento avicolo

2) Il candidato fornisca dei cenni sulle strategie messe in atto di recente in Italia per comunicare il livello di benessere animale al consumatore

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 25

1) Tipologie di mungitura nei bovini da latte

2) Cos'è un Istituto Zooprofilattico Sperimentale e quali sono i suoi compiti

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9 maggio 2025 ore 9:30

PROVA N° 26

1) Tipologie di allevamento cunicolo

2) Punti critici alimentazione dei ruminanti al pascolo

PROVA ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 27

1) Strategie di gestione delle scrofe iperprolifiche con problemi legati all'alimentazione del suinetto sottoscrofa

2) Come sono suddivise (aree di valutazione) le check list di Benessere animale ClassyFarm?

PROVA ESTRATTA
1

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9 maggio 2025 ore 9:30

PROVA N° 28

1) Parlami della curva di lattazione della bovina da latte e della corretta prassi di mungitura

2) Cenni relativi alla Iniziativa dei cittadini "End of Cage Age"

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9 maggio 2025 ore 9:30

PROVA N° 7

1) Normativa orizzontale in merito alla protezione degli animali negli allevamenti

2) Come si può valutare il consumo di farmaco antibiotico in una azienda zootecnica?

PROVA NON ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 5

1) Quali sono le 5 libertà fondamentali per il benessere degli animali da reddito?
2) Il candidato descriva come può essere utilizzato il macello per il rilievo dei parametri sanitari e di benessere nel suino

PROVA NON ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 4

1) Come si calcola la mortalità nelle bovine da latte, secondo la checklist Classyfarm?

2) Cosa si intende per materiale manipolabile? In quale specie è oggetto di forte discussione?

PROVA NON ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 23

1) Tipologie di allevamento bovino da carne

2) Il candidato esponga alcuni esempi di arricchimenti ambientali

PROVA NON ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 14

1) Nella valutazione del benessere animale cosa sono le misure Animal Based?

2) Il candidato descriva le principali tipologie di stabulazione delle bovine da latte

PROVA NON ESTRATTA

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9 maggio 2025 ore 9:30

PROVA N° 8

1) Quali sono le strategie per il suino che la Comunità Europea sta promuovendo in ambito legislativo?
2) Come si valuta la zoppia nelle bovine da latte, secondo la checklist Classyfarm?

PROVA NON ESTRATTA

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"BRUNO UBERTINI"
(ENTE SANITARIO DI DIRITTO PUBBLICO)

SELEZIONE PUBBLICA PER TITOLI E COLLOQUIO PER EVENTUALI ASSUNZIONI A TEMPO DETERMINATO DI PERSONALE NEL PROFILO DI COLLABORATORE TECNICO PROFESSIONALE ADDETTO AI SERVIZI DI LABORATORIO – AREA DEI PROFESSIONISTI DELLA SALUTE E DEI FUNZIONARI – CON LAUREA IN SCIENZE ZOOTECNICHE E TECNOLOGIE DELLE PRODUZIONI ANIMALI O LAUREA IN SCIENZE E TECNOLOGIE AGRARIE E FORESTALI DA ASSEGNARE ALLE SEDI DELL' ISTITUTO.

9 maggio 2025 ore 9:30

PROVA N° 9

1) Cos'è la "comfort zone" di un animale?

2) Quali sono le ABMs dirette nel suino

PROVA NON ESTRATTA

European Food Safety Authority

EFSA Journal 2012;10(

SCIENTIFIC OPINION

Scientific Opinion on the welfare of cattle kept for beef production and the welfare in intensive calf farming systems[1]

EFSA Panel on Animal Health and Welfare (AHAW)[2, 3]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

Information given in previous Opinions "Welfare of cattle kept for beef production" (SCAHAW, 2001) and "The risks of poor welfare in intensive calf farming systems" (EFSA, 2006) is updated and recent scientific evidence on the topics reviewed. Risks of poor welfare are identified using a structured analysis, and issues not identified in the SCAHAW (2001) beef Opinion, especially effects of housing and management on enteric and respiratory diseases are reviewed. The Opinion covers all systems of beef production, although the welfare of suckler cows or breeding bulls is not considered. The Chapter on beef cattle presents new evidence and recommendations in relation to heat and cold stress, mutilations and pain management, digestive disorders linked to high concentrate feeds and respiratory disorders linked to overstocking, inadequate ventilation, mixing of animals and failure of early diagnosis and treatment. Major welfare problems in cattle kept for beef production, as identified by risk assessment, were respiratory diseases linked to overstocking, inadequate ventilation, mixing of animals and failure of early diagnosis and treatment, digestive disorders linked to intensive concentrate feeding, lack of physically effective fibre in the diet, and behavioural disorders linked to inadequate floor space, and co-mingling in the feedlot. Major hazards for white veal calves were considered to be iron-deficiency anaemia, a direct consequence of dietary iron restriction, enteric diseases linked to high intakes of liquid feed and inadequate intake of physically effective fibre, discomfort and behavioural disorders linked to inadequate floors and floor space.

KEY WORDS

Beef cattle welfare, welfare of calves in intensive farming systems, risk assessment, updates.

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SUMMARY

Following a request from the European Commission, the Panel on Animal Health and Welfare (AHAW) was asked to deliver a Scientific Opinion on the welfare of cattle kept for beef production and of calves in intensive farming systems.

The European Commission is in the process of evaluating the European Union policy on animal welfare, taking account of socio-economic and trade issues. The overall aim is to improve the welfare of animals. To this end, the Commission requested EFSA to give an independent view on animal-based measures for the assessment of welfare in cattle, pigs and poultry. Before starting this work for beef cattle and calves, the Commission requested an update of scientific evidence relating to the welfare of cattle kept for beef production and calves in intensive farming systems; in particular, to consider the extent to which the conclusions and recommendations of two previous Scientific Opinions were still valid. These Opinions were the "Welfare of cattle kept for beef production" (SCAHAW, 2001) and "The risks of poor welfare in intensive calf farming systems" (EFSA, 2006).

The SCAHAW (2001) Opinion "The Welfare of Cattle kept for Beef Production" differed from EFSA Opinions, in that it did not include a formal animal welfare risk assessment. Over half the Opinion was a description of production systems, housing design and natural behaviour of cattle. Effects of housing, management and the environment on behaviour and some aspects of welfare were reviewed in detail. However, many factors with impact on welfare, such as breeding and genetics, feeding and feeding disorders, interactions between management, infectious disease and cattle welfare were reviewed only briefly or not at all. Where the SCAHAW (2001) Opinion was comprehensive (e.g. behaviour, mutilations), this current Opinion reviews only new evidence and only amends the conclusions and recommendations justified by this new evidence. Where the SCAHAW (2001) Opinion contains little or no evidence, it has been necessary to include references that precede 2001, and present new conclusions and recommendations. In this Opinion all systems for rearing cattle for beef production have been considered, ranging from intensive systems, where the animals are housed throughout life, to semi-extensive systems, in which animals are finished at pasture. The welfare of suckler cows and breeding bulls was not considered by SCAHAW (2001) and, to comply with the scope of the mandate, it is not considered here either. However, it is recommended that it be considered in a future mandate.

The Chapter on the welfare of calves in intensive farming systems adopts a similar approach to the previous Opinion (EFSA, 2006). It updates the review of scientific evidence and the approach to risk assessment, since developed and consolidated in the EFSA Scientific Opinion (2012) "Guidance on Risk Assessment in Animal Welfare". The production systems under consideration relate to calves, from the dairy herd reared for white veal, pink veal or prior to entry into beef production units. The welfare of unwanted "bobby" calves killed shortly after birth was not considered in the EFSA (2006) Scientific Opinion on the welfare of calves in intensive systems and, once again, to comply with the scope of the mandate it is not considered here. However, it is recommended that it be considered in a future mandate.

The impact of heat and cold stress on the welfare of beef cattle was not considered in SCAHAW (2001), so it has been reviewed in detail. Beef cattle can tolerate and adapt to a wide range of air temperatures, and metabolic heat production increases with increasing feed intake. Thus, animals on the highest rations are least sensitive to cold and most sensitive to heat. Cold stress can be reduced by provision of appropriate shelter and a dry lying area. Therefore, it is recommended that beef cattle confined in houses or open feedlots should be provided with structures and facilities to reduce the effects of factors contributing to thermal stress such as excess air movement, precipitation, relative humidity and solar load. Provided that these are effective there is no need to make provision for the control of air temperature.

Beef cattle kept on slatted floors have a higher incidence of injuries than animals on straw or sloped, partially straw-bedded areas. Partial rubberisation or rubber mats on concrete floors, especially for

lying areas, reduces the prevalence of lesions to claws and joints. However, wherever possible, cattle housed on slatted concrete floors should have access to a bedded area. Particular attention to the type of slats should be given to avoid slipperiness.

New evidence suggests that castration by rubber ring alone is less painful than a combination of Burdizzo and rubber rings. Rubber ring castration should be used in animals only under the age of 2 months and the scrotum cut after 8-9 days of ring application. Immunocastration has been shown to reduce aggressive and sexual behaviour in bulls. Surgical castration may lead to complications such as haemorrhage, infection, severe inflammation and tetanus. Approximately 35 % of beef cattle in Europe are disbudded and 15 % are dehorned by amputation. Nevertheless, disbudding or dehorning with sedation only, results in severe stress and pain. Therefore, cattle at any age should always be provided with local or regional anaesthesia at the time of surgical mutilations and systemic analgesia for two days or so thereafter.

Genomics and related technologies offer new opportunities for utilising existing genetic variability to improve several important welfare related traits, such as disease resistance, fertility, heat tolerance, and temperament. Selection tools have been successfully developed to identify carriers of deleterious genes and to control many genetic and environmentally-induced diseases. In the category of pathogen-associated disease, rapid progress is being made toward implementation of data collection, identification of DNA markers and development of tests that can be used in marker-assisted selection. Therefore, it is recommended that further research aimed at developing tools needed for implementation of marker-assisted selection to improve general resistance to disease.

Beef cattle fed intensively on high grain rations (< 15 % physically effective fibre) are at high risk of digestive disorders, especially sub-acute ruminal acidosis (SARA). Cattle that experience repeated episodes of SARA are at risk of rumen parakeratosis, liver abscesses and laminitis. Measures for the control of SARA include the feeding of buffers, drugs to stimulate salivation, and antibiotics (not permitted in the EU). Rations for finishing cattle should include at least 15 % physically effective fibre to reduce the risk of bloat, SARA and its sequelae. Feed supplements for the control of SARA should be restricted to those that stabilise rumen pH through natural buffering.

Most beef cattle diseases have a multi-factorial aetiology. In addition to pathogens and animal-related conditions, other contributing factors include environmental stressors that disturb homeostasis in the animal. These diseases can become chronic when infected animals are not detected and treated early. Chronic pneumonia results in very poor welfare with pain, asphyxiation and ill-thrift. Calves showing severe respiratory distress after multiple treatments should be killed on the farm. To promote effective control of multifactorial infectious diseases, cattle should be kept in environments that minimise physiological and emotional stress.

When calves are reared for veal production it is essential to provide solid feed containing adequate amounts of physically effective fibre in order to promote the development of a healthy and functional rumen, stimulate normal rumination behaviour and prevent abnormal oral behaviours. The conclusions of the EFSA (2006) Opinion concerning the iron requirement and clinical anaemia in calves reared for white veal are largely supported by new research. However, clinical signs of iron-deficiency anaemia, including suppression of normal behaviour, may already occur prior to an actual decrease of blood haemoglobin levels. In white veal calves oral supplementation with iron may improve milk intake and digestion in animals exhibiting normal haemoglobin levels. Other clinical and biochemical measures in addition to blood haemoglobin levels should be included as indicators of anaemia in order to safeguard the welfare of veal calves restricted in their dietary iron supply. However, this topic requires further research.

A reduction of the lying space allowance from 1.25 m^2 to 0.75 m^2 per animal for calves with a live weight up to 100 kg and a reduction from 1.50 m^2 to 1.00 m^2 per animal for calves with a live weight up to 150 kg decreased the occurrence of synchronous resting and reduced the opportunity to lie in a relaxed recumbent posture. Addition of an environmentally-enriched post-feeding area to an automatic milk-feeding system can significantly reduce cross-sucking in group-housed calves reared for veal. More research should be focused on pen design to improve calf comfort and achieve environmental enrichment that improves welfare. There is little evidence that floor type has an effect on the health of veal calves. However, the prevalence of bursal swelling in the knee was significantly higher in veal calves housed on concrete (approximately 17 %) than that in calves housed either on wooden slats (approximately 7 %) or on rubber or straw (< 1 %). However, provision of small amounts of straw or rubber mats for veal calves on wooden slats can result in discomfort from floors that are wet and dirty, unless the bedding is well managed.

Calves that do not get good quality colostrum after birth are more susceptible to endemic enteric and respiratory diseases. Calves from dairy farms must get an adequate quantity of colostrum at the most appropriate time. Environmental factors predisposing to respiratory disease were lack of ventilation, high animal density, extreme temperatures, high relative humidity and ammonia concentration. Ventilation should be regulated in order to keep ammonia concentrations as low as possible without creating draughts at the calf level. Group-housing of calves resulted in better welfare for this social species, except when there was significant enteric or respiratory infectious disease. In order to minimise the risk of poor welfare, calves should be managed so as to minimise exposure to enteric and respiratory infection. When there is a significant risk of cross-infection, it may be necessary to prevent direct contact between calves, but retain visual contact, during the first weeks of life by keeping them in individual pens or hutches.

Prevention of common calf diseases in the first 6 months of life, such as diarrhoea and the bovine respiratory syndrome, requires a systematic approach by improving management and housing conditions, specifically the preparation of the cow, hygiene of the calving environment, including dry clean bedding and high air quality, immediate supply with maternal antibodies, putting calves from different sources into different air-spaces, and no mixing with older animals, as well as careful attention and a rapid response to any sign indicating disease. Identifying sick animals in the early stages of disease is a crucial element for therapeutic success.

The hazard analysis identified the most serious risks to beef cattle and calves on the basis of magnitude and probability of adverse effect. The hazard analysis for beef cattle identified three major categories of welfare problem attributable to risks associated with housing and management:

- Respiratory diseases: linked to overstocking, inadequate ventilation, and mixing of animals, as well as failure of early diagnosis and treatment.
- Digestive disorders: linked to intensive concentrate feeding, lack of physically effective fibre in the diet.
- Behavioural disorders: linked to inadequate floor space, co-mingling in the feedlot and intensive concentrates.

The main welfare problems for intensively reared calves attributable to risks associated with housing and management were:

- Iron deficiency anaemia: a direct consequence of dietary iron restriction used to produce white meat.
- Digestive and respiratory disorders: linked to high intakes of liquid feed and inadequate intake of physically effective fibre, and cross-infection resulting from mixing of calves from multiple sources.
- Discomfort and disturbed resting behaviour: linked to inadequate floors and floor space.

animals

MDPI

Article

Effect of Heat Stress on Dairy Cow Performance and on Expression of Protein Metabolism Genes in Mammary Cells

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Simple Summary: Environmental temperatures are increasing, and consequent global warming also has negative effects on dairy cattle farms, which may result in reduced production and poorer milk quality. The protein content of casein, in particular, is important in influencing the coagulation properties of milk and, therefore, the production and quality of cheese. The aim of this study was to assess the effect of heat stress on animal performance and on the expression of selected genes involved in milk protein metabolism. Eight dairy cows were kept under thermoneutral conditions for 8 days. The same animals were then maintained under mild heat stress conditions for an additional 8 days. The results of this study revealed that mild heat stress reduced the feed intake and performance of dairy cows in terms of milk and protein yield, but not the expression of the target genes involved in milk protein metabolism, such as those coding for caseins.

Abstract: The aim of this study was to assess the effect of heat stress on dairy cow performance and on the expression of selected genes involved in milk protein metabolism. Eight Italian Holstein Friesian cows were kept under thermoneutral conditions (temperature–humidity index (THI) < 72, CON) for 8 days and under mild heat stress conditions (72 < THI < 78, HS) for an additional 8 days. The rectal temperature, feed intake, and milk yield were recorded during the last 3 days of the CON and HS periods. During the same time period, milk samples were collected to assess the composition and expression of selected genes involved in milk protein metabolism. Gene expression analyses were performed on somatic cells from milk, which are representative of mammary tissue. In terms of dairy cow performance, HS resulted in lower milk and protein yields and feed intake but higher rectal temperature than for CON ($p < 0.05$). Under HS, there were greater abundances of HSPA1A ($p < 0.05$) and BCL2 ($p < 0.05$), compared to CON, but similar levels of CSN2 ($p > 0.05$), CSN3 ($p > 0.05$), HSPA8 ($p > 0.05$), and STAT5B ($p > 0.05$) mRNA. Mild heat stress reduced the performance of dairy cows without affecting the expression of genes coding for caseins.

Keywords: heat stress; mammary gland; somatic cell; mRNA; Western blot; protein synthesis

1. Introduction

Global warming and climate change are among the biggest issues facing the world, and their economic impact on dairy farming is a relevant issue. The reduction in milk yield related to heat stress has led to estimated losses of 5.4% of the monthly income of farmers during summer [1]. This impact is expected to significantly increase in the future, with the annual average land temperature in Europe expected to increase by 1.0–5.5 °C by the end of the century [2].

The temperature–humidity index (THI) [3] is widely used to predict heat stress events in cattle, and a value of 72 points was initially considered to be the threshold at which heat stress begins [4]. This threshold was later reduced to 68 points for dairy cows that produce more than 35 kg/d [5]. The content of true protein in milk is important in terms of determining the primary income of farmers and also the dairy industry due to its influence on milk coagulation properties and, hence, cheese production and quality [6]. Heat stress can have a detrimental effect not only on dairy cow performance but also on the milk content of true protein and particularly caseins [7]. These changes could be the result of the indirect effect of reduced dry matter intake and of the direct effect (tissue hyperthermia) on mammary synthesis [8]. There are many studies available which investigate the effect of heat stress on the performance of dairy cows [9,10]. West et al. [11] explained that every additional 1 °C in air temperature above the thermal neutral zone causes a 0.85 kg reduction in feed intake, and that heat stress can cause a considerable reduction in milk production. Fewer studies have characterized the effects of heat stress on milk protein composition or protein fractions, and the results are often contradictory [7,8]. The effects of heat stress on the expression of genes involved in the synthesis of milk proteins are far from being well understood, and few in vivo studies are available [12,13]. When measured in vitro, heat stress increased the expression of heat shock proteins (Hsp) and of genes that code for milk proteins [14,15].

In the past, many studies on gene expression in bovine mammary glands were performed on mammary tissue collected at slaughter or through mammary biopsies that were invasive, did not ensure animal welfare, required surgical procedures, or did not allow for repetitive sampling without injuring the mammary gland. With the aim of avoiding these problems, one study demonstrated that somatic cells from milk are an effective source of mammary transcripts [16]. To our best knowledge, only one study that used milk somatic cells for assessing the effect of heat stress on gene expression in mammary cells is available [17], and this study was performed on goats.

It has previously been hypothesized that heat stress could also have a detrimental effect on milk composition by reducing the expression of target genes in mammary glands. Therefore, the aim of this study was to assess the effect of heat stress on milk production and composition in dairy cows, and on the expression of selected genes involved in milk protein metabolism in milk somatic cells.

2. Materials and Methods

The study was conducted in accordance with EU Directive 2010/63/EU and Italian legislation (DL n. 26, 4 March 2014), and adhered to the rules of the University of Udine. No invasive procedures were applied, and the adopted procedures were routine. The ethical committee of the University of Udine approved the trial (prot. no. 4/2017).

2.1. Animals, Treatments and Sampling

Eight multiparous Italian Holstein Friesian dairy cows in the last stage of lactation and belonging to one commercial farm were considered and transferred to the experiment farm of the University of Udine (Azienda Agraria Universitaria Antonio Servadei) where the trial took place. At the beginning of the trial, the animals had 271 ± 3.7 (mean ± SE) days of milk production, a mean milk production of 14.7 ± 0.84 kg, and a mean milk somatic cell count (SCC) of 131,625 ± 18,643 cells/mL. All animals had an SCC lower than 200,000 cells/mL, which indicated that the mammary gland was free from infection or physiological stress [18,19]. The animals were housed in a tie-stall barn equipped with a fan cooling system and 4 mini data loggers (FT-102; Econorma SAS, Treviso, Italy) that monitored the environmental temperature and relative humidity every second, and recorded averages every thirty minutes. The THI was calculated [3] on the basis of these data considering the hourly average value measured by the probes. The dimensions of the barn were 25 × 10 m with an average height of 4 m. After an adaptation period of 3 weeks, the animals were kept under thermoneutral conditions (CON; THI < 72) for 8 days with a fan used to help maintain these conditions. The same animals were then kept under environmental barn conditions that corresponded to mild heat stress conditions

animals

Article

Paratuberculosis, Animal Welfare and Biosecurity: A Survey in 33 Northern Italy Dairy Goat Farms

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Simple Summary: Paratuberculosis is a chronic incurable bacterial infection widespread all over the world in ruminants. The disease impacts animal health and welfare and causes significant economic losses in animal productions. This survey investigated the spread of paratuberculosis in northern Italian dairy goat farming by serological testing. Contextually, a welfare and biosecurity assessment through a standardized protocol was conducted. More than half (19 out of 33, 58%) of the investigated farms were infected, with a mean intra-herd prevalence of 7.4%. Welfare assessment showed quite favorable average results, although in 24% of the farms the welfare level was poor. On the contrary, 58% of the farms showed an unsatisfactory biosecurity level. Our results provide information on the spread of paratuberculosis in dairy goat farms of northern Italy. For this relevant disease, official prevalence data in goat breeding are still scarce. Moreover, the present work highlighted the low level of biosecurity measures implemented by the farmers.

Abstract: Paratuberculosis is a notable infectious disease of ruminants. Goats appear to be particularly susceptible. The survey aimed to investigate the spread of paratuberculosis in Italian goat farming and evaluate whether the presence of the disease could be influenced by welfare and biosecurity deficiencies. A serological survey for paratuberculosis in 33 dairy farms in northern Italy was conducted. Contextually, animal welfare and biosecurity were assessed, using a standardized protocol of 36 welfare indicators and 15 biosecurity indicators which assigns to each farm a welfare and biosecurity score from 0 (any application) to 100% (full application). An overall result of less than 60% was considered insufficient. Nineteen farms (58%) tested positive for paratuberculosis, with a mean intra-herd seroprevalence of 7.4%. Total welfare ranged from 39.56 to 90.7% (mean 68.64%). Biosecurity scores ranged from 10.04 to 90.01% (mean 57.57%). Eight farms (24%) showed poor welfare conditions (welfare score < 60%) and 19 (58%) an unsatisfactory biosecurity condition (biosecurity score < 60%). With respect to the explorative character of the study, an indicative association between seven welfare and biosecurity indicators and paratuberculosis seropositivity was identified. The presence of paratuberculosis in northern Italy dairy goat farms was confirmed. The welfare and biosecurity assessment protocol proved to be an accurate tool, capable of identifying critical points for managing health, welfare and productivity.

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Keywords: *Mycobacterium avium* subsp. *paratuberculosis*; MAP; dairy goats; serology; biosecurity; animal welfare assessment

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1. Introduction

Paratuberculosis is a chronic incurable enteritis of ruminants caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP) [1]. The transmission primarily occurs through the ingestion of infected feces.

The disease is important because of its impact on the economy, on the animal welfare and for public health in general [2]. Among domestic ruminants, goats appear to be particularly susceptible [3]. It has been observed that goats are naturally more susceptible to MAP infection than sheep and cattle and may play a more important role than sheep in the transmission and maintenance of the disease [2,4,5]. In goats, the onset of clinical signs is most common between two and three years of age, whereas subclinical infection is most often seen in the early years [2,6]. Indeed, paratuberculosis in this species is insidious and symptoms are usually not clearly evident. As a consequence, it is often diagnosed only at the latest state of disease when it has spread to most animals of the flock. Infected individuals often do not show diarrhea but non-specific signs as weight loss, exercise intolerance and decreased milk production [7]. Sardaro et al. [8] reported that economic losses and consequent profit inefficiency caused by the disease in breeding of small ruminants are due to decreased milk production, diagnostic and disease control costs, culling of affected animals and low carcasses values at slaughter. Surveillance and control of paratuberculosis can be of critical importance in some developing countries where small ruminants play a vital role in the livelihood of poor communities, as well in worldwide disadvantaged areas and in the increasing sector of intensive goat breeding [9,10].

Another important reason to investigate the disease in animals is related to the detection of MAP in humans affected by different chronic diseases, such as Chron's disease. These observations suggested a hypothetical zoonotic role for MAP that thus far, has not been confirmed or denied [11]. In this context, since several studies detected MAP in goat cheeses, often made from raw milk [12–15], from a health-risk point of view, contamination with MAP of foods of animal origin should be prevented.

According to the Regulation (EU) 2018/1882 [16], paratuberculosis is subjected to surveillance in cattle, buffaloes, sheep, goats, camelids and cervids.

Although the Regulation (EU) 2018/1882 clearly reports the obligation to notify the disease, because of scarce knowledge or difficulties in diagnosing subclinical infections [5], the disease is often underreported [2].

All over the world, paratuberculosis has been reported in goats [2]. In Europe, Nielsen and Toft [17] reported an inter-herd prevalence of infected goat herds over 20%. 5. Jiménez-Martín et al. [5] performed a cross-sectional investigation on 83 sheep farms and 70 goat farms in Andalusia (southern Spain) and detected an apparent seroprevalence of 90% in goat flocks and 66.3% in sheep flocks. In the same study, the estimated individual true seroprevalences were 8.4% for sheep and 25.2% for goats.

In Italy, goat farming is still considered marginal despite the fact that the presence of the species is recorded throughout the country (about 1,000,000 heads were reared in 2022, of which 300,000 dairy goats (https://www.vetinfo.it/, accessed on 11 April 2023) and it is expanding.

In Italy, paratuberculosis in goats was reported in Tuscany region (central Italy) [18] and Apulia region (southern Italy) [10]. This last epidemiological study was carried out in 419 semi-extensive dairy goat, sheep and mixed flocks and reported a true seroprevalence at flock level ranging from 63.8 to 92.4% in flocks with different species of small ruminants. Moreover, the same study reported, at individual level, statistically significant higher seroprevalence in goats, confirming the great sensitivity of this species to MAP infection [10]. To the authors' knowledge, no other published studies are available, underlining the scarcity of these data for most of the Italian regions, especially those where the breeding of goats represents an important local industry because of the cheese production and other typical products.

Notably, for its impact on goat health, paratuberculosis is one of the diseases–together with caseous lymphadenitis and caprine arthritis encephalitis–specifically considered for

Table 5: Rabbit categories

Category[(a)]	Definition
Kits	From birth to weaning
Growing rabbits	From weaning to slaughter age
Young females for breeding	From selection (as a breeder) till first service
Young males for breeding	From selection (as a breeder) till appropriate age for mating or semen collection
Breeding bucks	From first mating/semen collection to culling
Non-conceiving does	Non-pregnant does after weaning of their litters till the next successful service
Reproducing does	From first kindling till culling – depending on the moment of the production cycle, this may include pregnant, lactating and lactating pregnant does

(a): For this opinion, the animal categories **in bold** have been selected as target populations for the survey.

All these rabbit categories usually coexist in a farm in relation to the hazards that they are exposed to and the occurrence of certain welfare consequences; similarities can be found among some categories (e.g. growing rabbits and male or female young breeding rabbits), which makes it possible to divide commercially farmed rabbits into three major categories: kits, growing rabbits and reproducing does. For the scope of the survey and in the discussion throughout this opinion it was therefore agreed to limit the number of target populations to 3, i.e. kits, growing rabbits, and reproducing does.

3.3. Rabbit production systems

3.3.1. Introduction

Rabbit production is commonly based on a continuous and closed cycle, with all stages simultaneously present on the same farm, and it can be operated under different systems that are a combination of several factors/aspects (Figure 3). These include different building types with different equipment (ventilation system, lighting, feed distribution and drinking pipeline), in which different biosecurity measures may be applied to different animal genetics, housed with different systems and subjected to different management of reproduction, rearing, and feeding (Lebas, 2000; Cerolini et al., 2008; Lavazza et al., 2009; Italian Ministry of Health, 2019). All these factors, as well as their different combinations, may affect animal health and welfare to a varying extent.

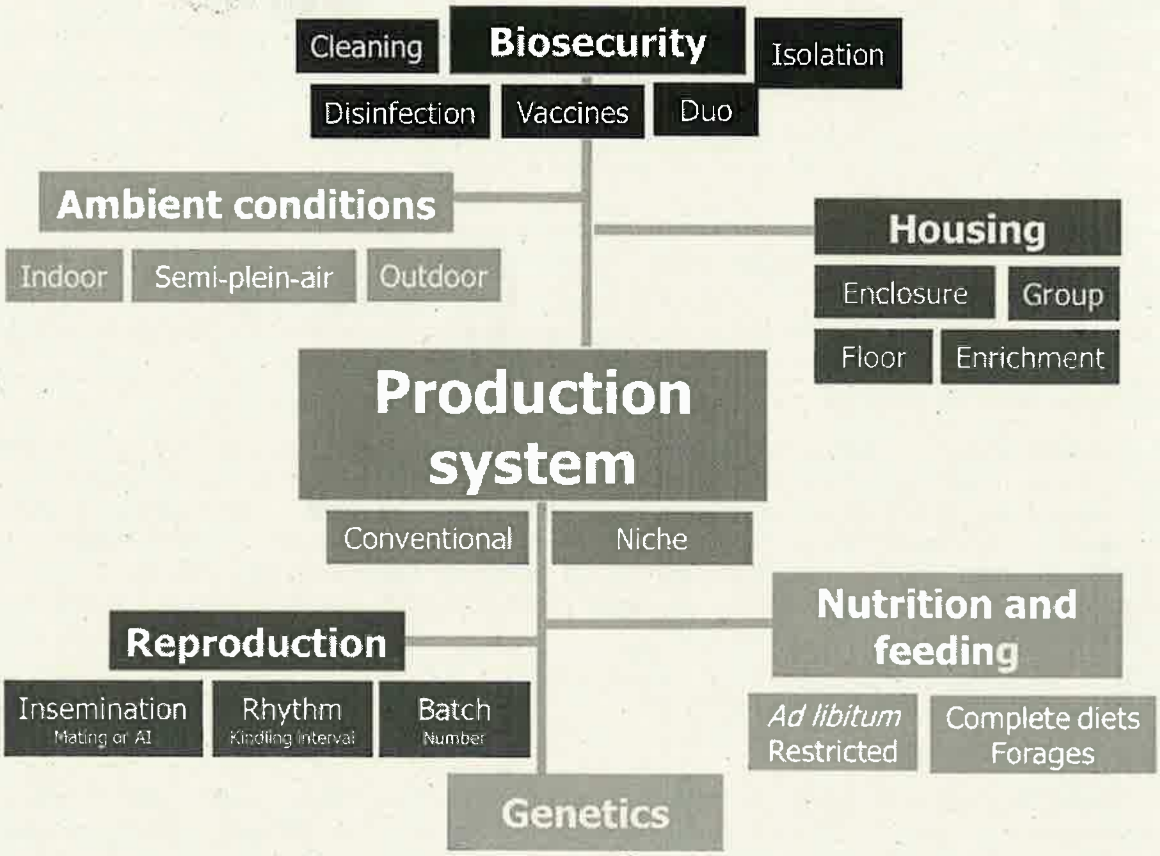

Figure 3: Production factors within conventional and niche production systems for rabbit farms

A variety of housing systems are used for rabbit farming. These range from conventional barren bicellular cages to alternative pen systems (commonly called 'parks'), recently introduced in some European Countries and required by the Belgian legislation (Belgium, 2014). Some management practices might be more frequently associated to one or another housing system and thus provide different hazards for health and welfare.

Despite not being fully exhaustive, the following chapters aim to address the main production factors within a rabbit production system, which may affect welfare and health to different extents

3.3.2. Genetic lines

Most of the industrial production comes from commercial crossbred rabbits (also called 'hybrids') based on the crossing of lines from pure breeds selected by genetic suppliers, e.g. Hypharm-Eurolap, Hycole, in France and Italy; in Spain: Universidad Politécnica de Valencia (UPV) and Institut of Agrifood Reasearch and Technology (IRTA), additionally to French lines; Zika in Germany; Martini in Italy. Some other commercial rabbit breeds are also available, e.g. SIKA in Slovenia and Pannon White in Hungary. The dam lines are usually based on New Zealand White and Californian medium-size breeds; the sire lines are usually based on heavy breeds. Among heavy breeds, most are based on the Flemish Giant, which has the highest adult body weight. Native breeds are mostly bred in small farms, backyard and hobby production.

11 During the last decades, in rabbits as in other meat species, the genetic selection has been mainly focused to improve traits linked to the increase of growth rate and amount of muscle mass (Gondret et al., 2005; Hernández et al., 2006), as well as the number of offspring and milk production in females. This may have had some collateral negative effects on robustness, which is defined as the capacity to maintain good production levels, keeping all body functions at the highest performance, in many different environmental/housing conditions and in different production systems of farmed animals; breed or line is a predisposing hazard to some diseases (Sánchez et al., 2012; Rosell and de la Fuente, 2018).

Selection for reproduction durability has efficacy in delaying senescence and these genetic lines have a lower sensitivity to external environmental factors, being likely mediated by higher body mass and energy supply (Pascual et al., 2013).

3.3.3. Provision of feed and water

In conventional farms, feed distribution can be manual or automatic, whereas in niche systems it is usually manual. In indoor and in semi-plein-air (semi-outdoor) systems, drinking is usually guaranteed by automatic distribution and nipple systems, whereas under outdoor conditions, suitable supplementary devices are necessary to assure water availability across all seasons. The water origin may be different, water main or well, and accordingly the chemical and microbiological quality of water may vary and thus should be regularly checked; finally, different cleaning and disinfection procedures may be adopted for the drinking systems (tanks, pipelines and drinkers).

Under most farming conditions, complete pelleted diets are used, and feeding is intended to cover the rabbits' physiological and nutritional requirements to assure their health and their productive performance (de Blas and Mateos, 2010; Maertens, 2010; Xiccato and Trocino, 2010; Gidenne et al., 2017a,b). The nutritional requirements depend on animal genetics, conditions for housing, management of reproduction and rearing/growing, as well as their combinations. Some dietary components, e.g. fibre fractions, also play a special role in the control of digestive diseases of the growing rabbit (Gidenne et al., 2010, 2015; Trocino et al., 2014).

Regarding breeding females, feeding is usually *ad libitum*. They usually receive a unique mixed diet formulated to meet the requirements of both the doe, or both the doe and kits, in one feeder. When kits begin to consume solid feed (around 17–21 days of age) they may consume the feed specifically formulated to satisfy the high lactation requirements during the first part of lactation. During the second part of the lactation (24–35 days post AI), the kits' may consume a feed more adapted to their digestive physiology (Xiccato et al., 2008; de Blas and Mateos, 2010). Feed restriction is not used for reproducing females. Nevertheless, young females selected for breeding may be restricted during their growth, using quantitative or qualitative restriction to avoid excessive fattening, especially when a later age is selected for the first insemination.

Regarding growing rabbits, the feeding programmes may be different and may use more diets to closely match the specific requirements for each growth stage or may use fewer diets (even only one). Feeding may be *ad libitum* or restricted. In France, using a 42-day cycle and slaughtering at 10–11 weeks, quantitative feed restriction (15–30% reduction from *ad libitum*) is usually applied in 95% of conventional farms during the first weeks after weaning, followed by a period of weak restriction or free intake, to reduce post-weaning digestive disorders and to improve the feed efficiency (Gidenne et al., 2017a,b). In the other producing countries, the use of quantitative feed restriction is a less common practice. Table 6 summarises the most common feeding programmes adopted in conventional farms for the different categories of rabbits (Maertens, 2010).

In outdoor or organic systems, supplementation with fresh forage or hay or access to grazing, besides the distribution of compound diets (pellets or whole grains) may be used. In organic systems, basic requirements according to EU Reg 2018/848 include access to pasture whenever conditions allow for it.

Table 6: Example of feeding scheme for conventional rabbit meat production (modified from (Maertens, 2010)

Rabbit category	Quantity	Diet
Males		
Young (until 18 weeks)	*Ad libitum*	Growing rabbits
Adult	Restricted (40 g/kg live weight)	Growing rabbits/specific diet for males
Young does		
Early mating (15–16 weeks)	*Ad libitum*	Growing rabbits
Late mating (17–20 weeks)	Restricted (40 g/kg live weight, followed by a 4-day flushing before insemination)	Growing rabbits or specific rearing diet
Does		
Late gestation	*Ad libitum*	Lactation

Rabbit category	Quantity	Diet
Lactating	*Ad libitum*	
	Kits < 3 weeks	Lactation
	Kits > 3 weeks	Weaners
In pre-gestation cages	Restricted (40 g/kg live weight), but *ad libitum* 4 days prior to insemination	Growing rabbits
Growing rabbits		
4–6/7 weeks	Restricted, 0.75 of *ad libitum*	Growing rabbits
6/7–10/11 weeks	*Ad libitum*	Growing rabbits/finishing

3.3.4. Management

3.3.4.1. Biosecurity

Within conventional rabbits farms, the biosecurity programmes are largely based on a series of provisions, requirements, rules, facilities and operational practices, all aimed: not only (1) to 'isolate' the farm environment from outside and thus to exclude the accidental introduction of disease-causing organisms into the farm, but also (2) to reduce pathogen spread and damage resulting from infectious agents already present in the farm.

The setup of biosecurity programmes has to consider all the different aspects of farming, i.e. management, structural requirements, cleaning and disinfection, isolation (i.e. control of people, animals and vehicles movements) and other biosafety measures, preventive treatments and direct prophylaxis actions (Lavazza et al., 2009; Italian Ministry of Health, 2019). Moreover, the differences existing between production systems may condition the applicability and influence the efficacy of such biosecurity programmes.

The closed cycle production system of rabbit reproductive does not permit the adoption of complete all in/all out procedures and corresponding cleaning and disinfection procedures (Huneau-Salaün et al., 2015). Therefore, the application of specific biosecurity measures is strongly recommended. This can be complemented by other measures of both direct (sanitary) and indirect (metaphylaxis/immunoprophylaxis) prevention (EFSA, 2005; Lavazza et al., 2009). In particular, infirmary and quarantine procedures, i.e. dedicated areas for ill animals and for entering animals, respectively, should be present and used in rabbit farms.

Specific vaccination programmes include those necessary for primary viral infectious diseases of lagomorphs such as myxomatosis and rabbit haemorrhagic disease (Rosell et al., 2019). This is defined in each area according to the epidemiological situation (EFSA, 2005; Italian Ministry of Health, 2019).

In some niche systems, certain specific biosecurity measures are impossible to realise. For instance, isolation from wildlife is difficult in systems with outdoor access.

3.3.4.2. Reproduction

Conventional farms mostly use artificial insemination (AI), which permits farmers to organise and schedule all the related operations inside the farm in a cyclic manner. Semen may be obtained from specialised farms/centres or from males reared and kept in the same farm, which implies that males may be absent or present in the farm. Usually, the doe is inseminated with 0.5 ml of fresh diluted semen (1:5 to 1:15) and immediately afterwards is subjected to an intramuscular injection of Gonadotropin releasing hormone (GnRH) synthetic analogue to induce ovulation. Natural mating is used only on small farms with few does as it is labour-intensive and time consuming, because it requires frequent movement of the animals between cages. Pregnancy lasts 30–31 days. It is diagnosed by abdominal palpation at 13–17 days.

The timing of AI after kindling determines the reproductive rhythm and the interval between two consecutive kindlings. Rabbit does are receptive and may be inseminated immediately after parturition. Nevertheless, under conventional conditions the most common reproductive rhythms are based on AI at 11–12 days or 17–18 days post-partum, which means an interval of 42 days or 49 days between two kindlings. An example of this reproductive rhythm is presented in Figure 4. Longer reproductive rhythms, with AI later than 25 days post-partum, are also applied.

At kindling, cross fostering and litter standardisation are usually applied when the does are healthy. The rabbit doe can give birth to 1–20 kits, but she can successfully nurse 8–10 kits. Thus, within 1–2 days after parturition, cross fostering is applied to standardise litter size and kits' weight within the same litter. The litter size nursed varies from 8 to 10 according to the doe parity and genetics. After

Pig category	Pig husbandry systems*	
	Full assessment in the General ToRs	Narrative description in the General ToRs
Animals in need of treatment or separation: all categories		Hospital/recovery or separation pens

*: All systems are indoor systems unless specified otherwise; for all categories, 'indoor' means 'without any outdoor access'.
**: For all pig categories, 'outdoor paddocks' means 'with access to soil'.

3.3.2. Gilt and dry sow systems

3.3.2.1. General management

Gilts destined to replace sows in the breeding herd come from maternal genetic lines bred for large litter sizes (Arey and Brooke, 2006; Prunier et al., 2010). Replacement gilts can be bred in the same production herds or purchased from specialist breeders as weaners (at about 30 kg liveweight).

In herds producing their own replacement gilts, animals are transferred to the breeding herd at the weight that their finisher pig counterparts are sent for slaughter while in some herds, gilts destined for the breeding herd are separated from finisher stock at an earlier age/weight and moved to specialised gilt rearing accommodation (Quinn, 2014). Replacement gilts are thereafter kept together; they may be fed in a similar way as when in the finisher accommodation, switched to a gestating sow diet or more commonly nowadays, transferred to a specially formulated gilt diet. Gilts usually have visual and olfactory contact with a boar in the gilt pens. They are typically served for the first time by AI at their second or third oestrus after puberty, when they are ~ 6–8 months old. 13

Sows are usually served at their first oestrus, approximately at 4–7 days after weaning. and while they are in stalls in the service house. However, on some farms, a boar is housed with a group of sows, and can serve them as they come on heat (for further details, see Section 3.2.2). 14

Once sows and gilts are served, the way in which they are housed depends on the herd size, the gestation housing system in use and the EU MS (see Section 3.3.2). In some very large herds, gilts are completely separated from the older sows for the entire pregnancy and may not join them in the breeding herd until they complete their first lactation. On smaller farms, with static groups and smaller group sizes, while pregnant gilts may share the same air space as older pregnant sows, they are usually kept in groups together and not mixed with them. On farms with large dynamic groups, pregnant gilts may be mixed into such groups with older sows. The way in which gilts are fed during pregnancy varies depending on the housing system.

3.3.2.2. Individual housing in stalls

Under EU legislation, gilts and sows can be kept in this system only for a limited period of time, i.e. gilts from service up to maximum 4 weeks after service, and sows from weaning up to maximum 4 weeks after service.

Individual or gestation stalls are the main housing system for pregnant sows and gilts from service up to farrowing worldwide (Ryan et al., 2015). In the EU, they are not permitted for use beyond 28 days post-service (Commission Regulation (EC) 889/2008[20]). Some MSs have stricter legislative restrictions on their use. For example, in the Netherlands, gilts and dry sows can only be held in stalls for a maximum of 4 days post-service, in Austria for a maximum of 10 days and Sweden not at all except for the actual insemination. In Denmark, in 2020 legislation has been passed that sows housed in buildings built after 2015 must be loose housed from weaning to farrowing; from 2035 this requirement applies to all sows. Similarly, Germany passed a legislation in 2020 introducing a ban on sow stalls, but it will not become mandatory until 2030. Stalls are a metal enclosure with a trough at the front and a gate at the rear. They have concrete flooring which is either fully slatted or with slats towards the rear and with solid concrete flooring in the anterior two thirds of the stall. They are seldom bedded. A long feeding trough runs the length of rows of individual stalls and the EU legislation requires for each stall to have water provision. Dimensions vary but stalls are typically ~ 2 m long and 0.7 m wide irrespective of whether they are used for sows or gilts. Facilities with older installations may have stalls of narrower widths (0.6 m). 15

These systems are further analysed in the General ToRs (see Sections 3.4 and 4.1) and in the section on Specific ToR 1 (Section 4.4).

[20] Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control. OJ L 250, 18.9.2008, p. 1–84.

3.3.2.3. Indoor group housing

Indoor group systems for pregnant sows and gilts represent the main housing system in the EU since 2013 (Commission Regulation (EC) 889/2008). They are generally characterised in terms of the feeding and grouping system (static/stable or dynamic/changing) employed. The choice between the two grouping 'systems' was traditionally based on herd size with smaller herds usually adopting static groups and dynamic groups being more common in larger herds. Nowadays however, it is possible to find both grouping systems in any herd size. In static groups, the group composition does not change once sows are introduced. That is no new animals enter the group and none of the group members leave (unless they are injured or return to service) until the entire group is moved to the farrowing unit (Bos et al., 2016). This is beneficial in that the dominance hierarchy remains stable once it is established and sows are only exposed to the stress of re-mixing once. In the past, static groups generally consisted of relatively small group sizes (between 4 and 12 sows). In groups of between 5 and 40 sows, the space allowance required by legislation (2.25 m^2/sow) is such that the amount of shared space is minimal, and that levels of social stress can be high. However, much larger static groups are an increasingly common feature of larger herds, and involve more shared space. One of the disadvantages to the farmer of static groups is that sows that are lost (i.e. die or are culled) from the system cannot be replaced, meaning that a sow space lies empty. Management of sows that return to service ('repeats') can also be difficult: repeats generally remain in the group and are either moved into stalls or allowed to remain on their own in the otherwise empty pen when their pen mates are moved to the farrowing house. The latter option means that the pen is in-use longer than it should be, which can put pressure on the rest of the system. In dynamic groups, the group composition changes weekly with served sows entering the group and sows due to farrow exiting. Sows in large dynamic groups are therefore continuously exposed to the stresses of re-mixing (Durrell et al., 2002). However, as dynamic groups are almost always associated with large group sizes, there are benefits associated with large amounts of shared space such as more room to exercise (Durrell et al., 2002). Furthermore, in such systems, there is more space for subordinate and otherwise vulnerable sows to avoid the aggressive encounters arising at the introduction of new sows each week. As the composition of a dynamic group is in a continual state of change it is well suited to handling repeats.

The design of group housing systems is generally focused around the choice of feeding system and this can also influence the flooring used. Dump feeding is whereby feed is automatically dropped onto a solid area of floor. Competition for access to feed is usually intense in this system. With spin feeding, the feed is spread over a larger area than with dump feeding, ranging from 6 to 24 m. Theoretically, this gives all sows in the group better access to feed (Spoolder et al., 2009). This system is used for groups of up to 25 sows suiting herds of 350–600 sows but like dump feeding, it results in intense competition for access to feed and variable body condition within groups. More than half the floor is solid with such a system. Free access stall systems are where sows were fed from a long trough but separated from one another during feeding by full length divisions or stalls. Traditionally, sows in this system were kept in small groups of four to six sows where the small amount of shared space was more than compensated for by the presence of full-length stalls in which the sows could escape from aggression/hide, etc. (Andersen et al., 1999). The feeding stalls were dual purpose in that they were also wide enough for sows to use them for lying. Pens are often fully slatted. Similarly, sows in larger static groups (10–20 sows) are also kept in, often fully slatted, pens in which they feed from a long stainless steel communal trough without any partitions along one side of the pen. A modification of such a system involves 'trickle feeding' whereby an auger slowly drops feed, usually at a rate of 100–120g/min, from calibrated hoppers into the troughs simultaneously to accommodate the slower feeding sows (Hulbert and McGlone, 2006). While such a system should remove the need for trough divisions, in practice at least shoulder length partitions 0.45 m apart (one per sow) are used. Electronic sow feeding (ESF) stations are the only way that automated individual rationing of sows can be achieved with group housing (Chapinal et al., 2008). Obviously, sows cannot feed simultaneously in ESF and the sight and sounds of a sow feeding in the station stimulates the motivation to feed in the animals waiting outside. Sows fed by ESF are identified by an ear transponder, enter the feed station through a rear gate and are fed a preset amount of feed, depending on the stage of pregnancy and body condition. Feed allocation is computer controlled and with individual feed scales being entered into the computer. While very large herds may keep sows in large static groups each with an ESF, this feeding system is often synonymous with dynamic grouping systems. Pens may be split into separate solid floored lying 'bays' or can be large/open undifferentiated fully slatted spaces.

These systems are further analysed in the General ToRs (see Sections 3.4 and 4.1) and in the section on Specific ToR 1 (Section 4.4).

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ORIGINAL RESEARCH
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Evidence of Pain, Stress, and Fear of Humans During Tail Docking and the Next Four Weeks in Piglets (*Sus scrofa domesticus*)

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Tail docking is widely performed in pig farms to prevent tail biting. We investigated the consequences of this practice on behavioral indicators of pain and stress, and on the human-piglet relationship during lactation. Within 19 litters, piglets (1–3 days of age) were submitted on day 0 (D0) to docking with a cautery iron (D), sham-docking (S), or no docking (U). Piglets from the D and S groups were observed during the procedure (body movements and vocalizations) and just after, in isolation, during 20 s for body, tail and ear postures as well as ear movements. Piglets from the three treatments were observed in their home pen after docking on D0 and D3 afternoon for body posture, tail posture and movements. Piglets from the D and U groups were observed on D6, D12, D19, and D26 in their home pen for oral behavior, body, and tail posture. Tail damage and tear staining were scored on D5, D11, D18, and D25. A 5-min motionless human test was performed on D14. During the procedure, D piglets screamed more and with a higher intensity ($P < 0.05$) than S piglets ($n = 48$–50). Just after docking, D piglets held their ears in a posture perpendicular to the head-tail axis and changed their ear posture more often ($P < 0.05$). Between D6 and D26, D piglets kept their tail immobile ($P < 0.001$) and in a horizontal position ($P < 0.01$) more often than U piglets ($n = 45$–47). Between D11 and D25, U piglets had higher scores for tail damage and damage freshness than D piglets ($0.09 < P < 0.02$) whereas tear-stain score was similar. In the human test, D piglets interacted later with an unfamiliar human than U piglets ($P = 0.01$, $n = 18$/group). Present data indicate signs of acute pain and stress in piglets due to docking during the procedure itself and adverse consequences throughout lactation thereafter, including on their relationship with humans. On the other hand, the presence of tail lesions shows that undocked piglets are subject to more tail biting, even before weaning.

Keywords: ear posture, lactation, tail posture, vocalization, welfare

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INTRODUCTION

Tail docking is commonly performed to prevent tail biting in pigs as it reduces its prevalence 2–4 fold (1, 2). However, according to EU regulations it should not be used routinely (3). The tail is sensitive, as it is innervated (4), and there is some evidence of immediate pain and stress consequent on tail docking. Piglets struggle more during the procedure than sham operated animals

(5) and they vocalize more and at higher frequencies (5–7). In the following minutes, tail wagging, tail movements, and the time spent sitting increase (5–7). Reports of the expression of pain-like behaviors (including scooting, jamming, and hunching) in the 120 min following the procedure are not consistent: some studies observed an increase in these behaviors (7) while other did not (8). The presence of neuromas detected at slaughter (4, 9, 10) suggests the existence of longer term consequences. However, only a few studies have evaluated these consequences. Most studies have focused on the tail biting consequences of not docking the tail (11) and not on the painful consequences of docking. To our knowledge, no study has attempted to observe behavioral signs of pain in the weeks following tail docking. In addition, as docking involves human intervention, human-animal relationship could be affected. Indeed, piglets may associate the negative states (fear and pain) due to docking with human presence and thus develop fear of humans, as has been observed after castration (12). The aim of the present study was to determine the consequences of tail docking on behavioral activity until weaning. We hypothesized that: (1) tail docking is a stressful and painful practice that modifies piglets' behavioral activity, tail, and ear posture shortly after the event, (2) pain and stress are maintained in the weeks following the practice and should lead to modifications of behavior including tail posture and movements or general activity, and (3) docked piglets will develop fear reactions toward humans in the weeks following the event.

MATERIALS AND METHODS

Animals and Rearing Conditions

The experiment was performed on two batches of animals, being born either in December 2013 (9 l) or in January 2014 (10 l). All piglets in the study were born from 19 (Large White * Landrace) sows inseminated by Pietrain semen, which farrowed between Wednesday morning and Thursday evening for a given batch. Sows and their litters were reared in 1.8 m * 2.4 m farrowing pens, with crates, on plastic slatted floors with a rubber mat for piglets. Ambient temperature was set at 22°C. In addition, two infra-red lamps (on for the first week) were available to the piglets. Sows were fed with a standard lactation diet provided *ad libitum*. Sows and piglets had permanent access to fresh water. Piglets had free access to creep feed from 10 days of age. Average litter size at treatment and at weaning were 11.4 ± 1.2 and 11.3 ± 1.1 piglets, respectively (mean ± SD). In the experimental litters, a total of five experimental (2I and 3D) and seven non-experimental piglets (within 3 l) were cross fostered. Cross fostering occurred at least the day before treatment application.

Piglets Treatments

On Thursday, experimental piglets were fitted with one colored ear tag, at random in the left or right ear, to facilitate their identification from a distance. On Friday morning (Day 0 = D0), piglets, which were then 0.5–2 days of age, were submitted within litters to one of three treatments: docked (D, $n = 48$), sham-docked (S, $n = 50$), and undocked piglets (U, $n = 47$). They were marked on their back with a special marker, so that that they could easily be identified during the behavioral observations. Whenever possible, only females were used and were equally distributed between treatments. However, due to variation in the number of females per litter, we had to include 27 male littermates. These were allocated only to the S treatment since animals from this group were observed only during the first two phases of the experiment (see Behavioral Observations), before the occurrence of surgical castration which was routinely performed in the herd at the time of the experiment. To our knowledge, there is no sex effect on pigs' behavior during the first 3 days of age. In addition, statistical analyses were performed to test for an effect of sex (27 males vs. 23 females) on the various behavioral variables within this experimental group and no statistically significant differences were detected ($P > 0.14$). Overall, each litter comprised 5–11 experimental piglets, with at least one piglet per treatment in 3 l and at least two piglets per treatment in the remaining 16 l (**Supplementary Table 1**).

For docking, all S and D piglets belonging to 1 l were removed simultaneously from the farrowing pen, placed in a cart bedded with fresh wood chips and transported to a separate room to undergo treatment and behavioral observations. One piglet was randomly removed from the cart by a trained handler. Immediately after removal, the treatment (S or D) was applied using a predetermined allotment established so that treatment of the first piglets of a litter was alternated and treatment of littermates was also alternated. Docking was performed with an electric-heated scissor docking iron leaving about 3 cm of the tail. This procedure took ~2 s. Sham docking was similar except that the piglet was not docked but its tail was placed on an iron bar for 2 s. Immediately after docking or sham-docking, the treated piglet was placed alone in a second partitioned cart, bedded with fresh wood chips, for 20 s of behavioral observation. Thereafter, it was moved to the other side of this second cart. The two sides of the cart were separated by a non-transparent wooden partition. Once all S and D piglets from 1 l had been treated, they were returned to the farrowing pen in the cart.

Iron injection and ear tattooing were performed on all piglets on D4 and weaning occurred at 4 weeks of age (D29).

Behavioral Observations

The experiment was divided into four phases (**Table 1**):

Phase 1. During docking or sham docking, we compared the body movements and vocalizations (description in **Table 2**) of all 48 D and 50 S piglets. We recorded the maximum volume of the vocalizations using a sound level meter (Extech Instruments Co, USA) placed 1 m away from the head of the piglet during the process. The number of each category of vocalizations was counted by an experimenter trained to recognize the categories, which are clearly distinct. The number of body movements was counted by continuous focal sampling from video records (camcorder Sony HDR-XR200VE) with The Observer 11 (Noldus, Netherlands). The observation started once the experimenter held the piglet and

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Review

Animal Welfare and Food Safety Aspects of Confining Broiler Chickens to Cages

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Simple Summary: In commercial chicken meat production, broiler chickens are usually kept on the floor in ware-house like buildings, but the use of cages is becoming more common. Confining chickens to cages is a welfare problem, as has been thoroughly demonstrated for laying hens used for egg production. Caged broiler chickens may suffer from poor bone strength due to lack of exercise, feather loss, and restriction of natural behavior. There are also potential food safety concerns associated with the use of cages. While cages may provide an economic advantage in some geographical regions of the world, the severe, inherent disadvantages should also be considered before cages are more widely adopted in the global broiler chicken industry.

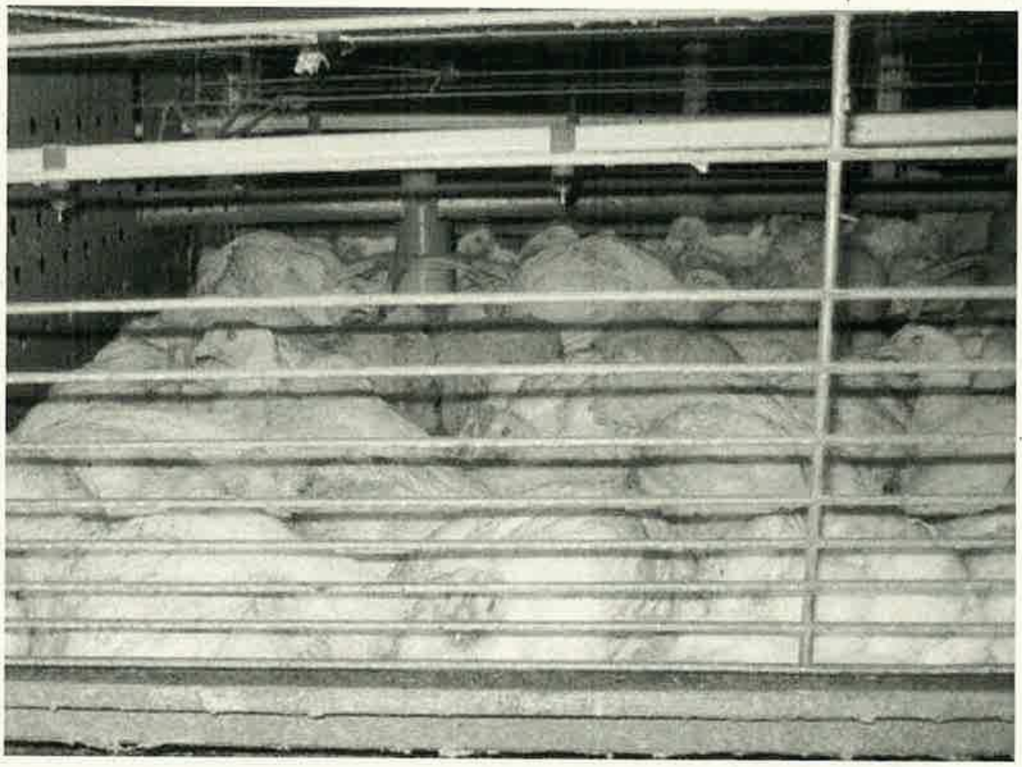
Abstract: In most areas of the world, broiler chickens are raised in floor systems, but cage confinement is becoming more common. The welfare of broiler chickens in cages is affected by movement restriction, poor bone strength due to lack of exercise, and prevention of key behavioral patterns such as dustbathing and ground scratching. Cages for broiler chickens also have a long history of causing skin and leg conditions that could further compromise welfare, but a lack of controlled studies makes it difficult to draw conclusions about newer cage designs. Cage environments are usually stocked at a higher density than open floor systems, and the limited studies available suggest that caging may lead to increased levels of fear and stress in the birds. Further, birds reared on the floor appear less likely to harbor and shed *Salmonella*, as litter may serve as a seeding agent for competitive exclusion by other microorganisms. Cages for laying hens used in egg production have met with substantial opposition due to welfare concerns and caging broiler chickens will likely be subject to the same kinds of social disapproval.

Keywords: broiler; welfare; cage; food safety; behavior; stocking density; leg problems

1. Introduction

Litter-bedded floor systems are common for raising broiler chickens used for meat production. In contrast, the egg industry has relied heavily on battery cages—small, wire enclosures that typically hold five to ten laying hens. Although cages for broiler chicken production have been available for many years, they were not widely adopted because heavy broiler chickens are prone to leg deformities [1–3], breast blisters [4], and other skin imperfections such as enlarged feather follicles [5] due to abrasion against the wire cage floor [6–8] and these problems have adversely affected meat quality [7,9]. Another problem is the comparatively short time period that broiler chickens are confined to cages before they reach market weight, and the concomitant labor requirements associated with moving chickens into and out of cages [4].

Figure 1. Caged broiler chickens (Photo by Sonia Faruqi).



Despite the obstacles, interest in developing a cage system that works well for broiler chickens has been ongoing since the 1960s [10]. A variety of cage floor materials have been tested including plastic tubing; plastic and metal mats [5,11]; rubber-covered nylon [12]; bamboo [8]; wire, steel and plastic mesh; perforated Styrofoam; padded doweling [13]; polyester urethane foam [14]; and wooden slats [15]. In the early 1970s a composite mesh floor material was patented, which helped solve earlier

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Predicting morbidity and mortality using automated milk feeders: A scoping review

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ABSTRACT

Automated milk feeders (AMF) are computerized systems that provide producers with a tool that can be used to more efficiently raise dairy calves and allow for easier implementation of a high plane of nutrition during the milk feeding phase. Automated milk feeders also have the ability to track individualized behavioral data, such as milk consumption, drinking speed, and the number of rewarded and unrewarded visits to the feeder, that could potentially be used to predict disease development. The objective of this scoping review was to characterize the body of literature investigating the use of AMF data to predict morbidity and mortality in dairy calves during the preweaning stage. This review lists the parameters that have been examined for associations with disease in calves and identify discrepancies found in the literature. Five databases and relevant conference proceedings were searched. Eligible studies focused on the use of behavioral parameters measured by AMF to predict morbidity or mortality in preweaned dairy calves. Two reviewers independently screened titles and abstracts from 6,675 records identified during the literature search. After title and abstract screening, 382 studies were included and then assessed at the full-text level. Of these, 56 studies fed calves using an AMF and provided some measure of morbidity or mortality. Thirteen examined AMF parameters for associations with morbidity or mortality. The studies were completed in North America (n = 6), Europe (n = 6), and New Zealand (n = 1). The studies varied in sample size, ranging from 30 to 1,052 calves with a median of 100 calves. All 13 studies included enteric disease as an outcome and 11 studies evaluated respiratory disease. Of the studies measuring enteric disease, 8 provided disease definitions (n = 8/13, 61.2%); however, for respiratory disease, only 5 provided a disease definition (n = 5/11, 45.5%). Disease definitions and thresholds varied greatly between studies, with 10 using some form of health scoring. When evaluating feeding metrics as indicators of disease, all 13 studies investigated milk consumption and 6 and 7 studies investigated drinking speed and number of rewarded and unrewarded visits, respectively. Overall, this scoping review identified that daily milk consumption, drinking speed, and rewarded and unrewarded visits may provide insight into early disease detection in preweaned dairy calves. However, the disparity in reporting of study designs and results between included studies made comparisons challenging. In addition, to aid with the interpretation of studies, standardized disease outcomes should be used to improve the utility of this primary research.

Key words: dairy calf, computerized feeder, automated milk feeder

INTRODUCTION

During the preweaning period, dairy calves are especially susceptible to infectious diseases (Svensson et al., 2003). A Canadian survey completed in 2015 identified a 6.4% mortality rate in preweaned female dairy calves, with 66% of these deaths occurring in the first 3 wk of life (Winder et al., 2018). A similar study recently published in the United States found a similar calf mortality rate of 5% (Urie et al., 2018a). The largest disease concerns in early life are enteric and respiratory diseases (Uetake, 2013). It is estimated that 23% and 22% of calves are given an antimicrobial to treat diarrhea and respiratory disease, respectively (Windeyer et al., 2014). Respiratory disease and diarrhea in early life can lead to reduced growth and reduced future milk production (Svensson and Hultgren, 2008; Windeyer et al., 2014; Dunn et al., 2018), making the early detection of these diseases vital to calf health and productivity.

Group housing of dairy calves has increased in popularity in North America due to the perceived reduction in labor requirements and the increased animal welfare benefits (Costa et al., 2016; Medrano-Galarza et al.,

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2017). However, as producers commonly detect disease in calves by monitoring subtle behavioral changes and differences in health indicators, these may be difficult to identify when calves are housed in groups. Producers often underdiagnose diarrhea and respiratory disease in group-housed calves, allowing these illnesses to go undetected for a longer period of time (Sivula et al., 1996; Medrano-Galarza et al., 2018). Often these diseases are not detected until significant clinical signs of disease are present (Cramer and Stanton, 2015). Due to the substantial overlap between human and livestock antimicrobials, there is a growing concern to decrease antimicrobial usage in dairy production to combat antimicrobial resistance (Langford et al., 2003). Earlier detection of disease may allow for interventions that are alternatives to antimicrobials. In group-housed calves, this could lead to reduced calf morbidity and improved growth in replacement heifers (McGuirk, 2008).

Automated milk feeders (**AMF**) collect data that could provide insight for producers to detect behavioral changes associated with the development of disease (Costa et al., 2021). Many allow producers to track a wide variety of individualized feeding metrics for each calf, including daily milk consumption, the speed of milk consumption, and the number of rewarded and unrewarded visits. Researchers have identified changes in specific behavioral parameters measured by AMF exhibited by calves before disease detection, such as decreased daily milk consumption, slower drinking speed, and a decreased number of unrewarded visits (Svensson and Jensen, 2007; Knauer et al., 2017; Sutherland et al., 2018). A recent study has also observed differences in these parameters when comparing clinical and subclinical disease in calves (Cramer et al., 2020). However, no formal synthesis of this literature has been performed. As AMF are increasing in popularity across Canada and the United States (Medrano-Galarza et al., 2017; Urie et al., 2018a), it is necessary to determine specific behaviors and thresholds for disease identification to allow producers to identify disease with more certainty.

A scoping review can be used to describe the main characteristics and identify possible knowledge gaps in a broad research field (Arksey and O'Malley, 2005). Scoping reviews differ from a traditional systematic review in that the authors do not analyze the quality of the included studies (Levac et al., 2010). These reviews are often common in emerging areas of research, where the number of published studies may be too small to undertake a full systematic review (Levac et al., 2010). The research surrounding AMF is limited, which lends itself to the use of a scoping review compared with a traditional systematic review. The objective of this scoping review was to characterize the body of literature investigating the use of AMF to predict morbidity and mortality in preweaned dairy calves. The review will list the parameters that have been examined for associations with disease and death in calves and discover gaps in knowledge.

MATERIALS AND METHODS

Protocol and Registration

A scoping review protocol was developed using the PRISMA extension for scoping reviews (PRISMA-ScR; Tricco et al., 2018). The protocol was established prior to the beginning of the study and was published in the University of Guelph Atrium (Morrison et al., 2019).

Eligibility Criteria

Only primary research was eligible for inclusion, including all types of analytical studies. The population was limited to dairy calves of any breed or sex that were fed using an AMF for all or a portion of the preweaning period. Studies must also have looked into associations between AMF feeding metrics and disease outcomes. To be included, publications must have been written in English and be at least 500 words in length. No geographical or date restrictions were placed other than the date restrictions imposed by the databases themselves.

Information Sources

Five electronic databases were searched to find potentially eligible articles: Medline via Ovid (1946 to present); CAB Direct via CAB (1920 to present); ProQuest via Agricultural and Environmental Science Database, Biological Science Database, Dissertations and Theses @ University of Guelph (1946 to present); Web of Science via Clarivate (1900 to present); and Scopus (1970 to present). American Association of Bovine Practitioners conference proceedings from 1997 to 2019 and World Buiatrics Congress proceedings from 2002 to 2019 were hand searched by a single reviewer.

Literature Search

The literature search was completed on September 6 and 7, 2019. We searched for records using a list of search terms related to dairy calves and the use of AMF, designed to maximize sensitivity. Table 1 shows the full search string used, which was then formatted appropriately for each of the database platforms. Records found in the searches from all databases were uploaded into Endnote X9 (Clairvate Analytics, Philadelphia, PA) reference management software, and duplicate refer-