Some preslaughter feeding and other environmental effects on aspects of gut microbiology of cattle and chickens.

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Abstract

Controlling microorganisms, especially pathogenic bacteria, in meat-producing animals destined for slaughter is important for reasons of consumer food safety, profitability and animal welfare. It is difficult for the consumer to accurately assess the safety of meat products, which means that meat must be provided with some form of assurance that it will be safe to eat. The overall objective of this work was to investigate approaches to improving food safety through preslaughter manipulation of gut microorganisms in cattle and chickens. The preslaughter feeding treatment of cattle, which offered the most advantages in the first study, was the provision of hay for 48 hours before despatch to slaughter. This method helped to reduce the gut burden and excretion of *Escherichia coli (E. coli)* and it helped keep the animals clean. Cattle that were transported directly from pasture had runny faeces and ended up with more surface soiling on the hide. Fasted animals produced less effluent during transport, but they had high levels of *E. coli* in their rumens and faeces at slaughter. The way the cattle were fed before slaughter had little effect on the amount of weight they lost. These results were confirmed in the second study involving eight preslaughter feeding regimes, with cattle fed red clover hay for 48 hours prior to transport to slaughter having reduced *E. coli* counts in the rumen to less than 1 log count g^{-1}. It is recommended that preslaughter fasting of cattle be reduced to 18 hours or less, including transport, to minimize gastrointestinal *E. coli* counts at slaughter and to minimize losses in carcass weight. The addition of commercial additives (a pre- and a syn-biotic) to the diet of chicks in their growing environment improved the chick growth rates and weights, however it also caused increased *Eimeria tenella* infection, following a challenge, resulting in significantly higher lesion scores. The presence of hens imparted partial resistance to infection to the chicks, but negatively affected their growth rates compared to chicks raised without hens.

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Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

The importance of controlling microorganisms, especially pathogenic bacteria, in meat-producing animals destined for slaughter must be appreciated for reasons of consumer food safety, profitability and animal welfare. The extent to which a meat quality characteristic influences a consumer depends on the accuracy with which it can be assessed by the consumer and the degree to which it is likely to deviate from a satisfactory level (Purchas *et al.*, 1989). Meat quality characteristics, such as safety and wholesomeness characteristics, are of high importance to consumers. A safe product is one which will not adversely affect the health of the consumer and a wholesome product is one which complies with the characteristics the public expects, even if the presence of an undesirable defect does not create a health hazard. However, it is very hard for the consumer to accurately assess the safety of meat products. This means that meat that is produced must be provided with some form of assurance that it will be safe to eat. Relevant aspects of, and interrelationships between, food safety, profitability and animal welfare are outlined in this introduction.

1.1 FOOD SAFETY

Food-borne illnesses are among the most widespread diseases of the contemporary world. It is estimated that seven million people a year are affected by food borne illness and, that 7000 die (Byrne, 1998). Many agents of food-borne disease are carried by red meat animals and poultry but there are wide differences between and within species in the incidence of affected animals and numbers of bacteria present (Mackey, 1989). Preventing humans from suffering the effects of food contamination clearly starts at the agricultural stage, and this is not only true of livestock, but also crops (Byrne, 1998). The chain of events involved in primary production, harvesting, processing, distribution and final preparation is quite long, and there are many opportunities for the food to become contaminated (Notermans, 1999). It is important to attempt to minimise the carriage of pathogens in live animals and the contamination of carcasses in the processing plant.

Markets demand safe, wholesome products because food safety is top priority among consumers. Food manufacturers need to be assured that the raw materials they use are wholesome (Byrne, 1998). Contamination of beef and poultry products leading to food poisoning in consumers could cause decreased consumption of these products. Incidents such as the *Escherichia coli* O157:H7 food poisoning outbreak in Scotland that killed twenty people and outbreaks of food poisoning caused by *Salmonella* and other bacteria, have threatened food supplies in Japan, the United States of America and the United Kingdom, and have shaken consumer confidence in the agro-food industry (Byrne, 1998).

The beef and poultry meat industries are very important economically, to New Zealand, both domestically and internationally. In 1999-2000, New Zealand exports of beef and veal made up 8% of the world export market, worth $1400.4 million with major beef markets including the United States, Canada, Japan, South Korea and Taiwan (Anon, 2001). In 1998, the New Zealand poultry industry produced 100,000 tonnes of poultry meat, almost solely for the domestic market, earned almost $500 million in retail sales, and provided about 3000 jobs (PIANZ, September 2001).

Decreasing the number of foodborne pathogens carried in and/or on animals to the processing plant and therefore the chance of contamination will help to ensure that both the domestic and international markets for beef and poultry products continue to grow. Important pathogens in the microbial contamination of meat include *Salmonella* and *Escherichia coli*.

Salmonella causes hundreds of thousands of foodborne infections each year by contaminating meat and other foodstuffs of animal origin (Oosterom, 1991; Portillo 2000). The number of *Salmonella* infections has steadily increased in the last few decades, mainly due to the continuous growth of industrialisation in animal husbandry, slaughter procedures and food processing (Oosterom, 1991). *Salmonella* infections lead to a variety of diseases known as salmonellosis.

Escherichia coli may be the most versatile of human pathogens (Donnenberg and Nataro, 2000). *E. coli* is a common organism found in the gastrointestinal tract of warm

blooded animals and humans (Mermelstein, 1993). This organism is not only the dominant gram-negative facultative anaerobe in the human gastrointestinal tract, it is also a potent pathogen capable of a variety of diseases by an array of mechanisms (Donnenberg and Nataro, 2000). Some strains can produce enteric, urinary tract and wound infections as well as food poisoning, and occasionally septicaemia and meningitis (Eley, 1996).

1.2 PROFITABILITY

Abattoirs do not like diseased or heavily contaminated animals. When meat has to be discarded because it is spoiled through contamination or disease, profitability is decreased. Microbial contamination of animal carcasses is a result of the necessary procedures required to process live animals into retail meat (Dickson and Anderson, 1992).

Making sure that there is a continuous supply of suitable stock to the killing floor has implications for line efficiency and animal welfare in four ways. Animal handling becomes more critical as the animals must arrive in a continuous stream at the stunning point (Gregory, 1998). Uncontrolled behaviour in the stock can create interruptions in this flow.

The animals must be healthy and free from blemishes. Diseased and bruised or blemished tissue needs to be removed, and the additional inspection and trimming this involves can slow the line or require extra trimming (Gregory, 1998). Extra work is involved in trimming the diseased tissues and if there are a lot of diseased animals the line speed will be reduced (Gregory, 1998). Under commercial beef slaughtering conditions, trimming may be a highly variable process, with its efficacy primarily related to the skill and/or diligence of the individual doing the trimming (Prasai *et* al., 1995; Reagan *et al.*, 1996). The physical contact with the carcass during trimming may contribute to additional contamination if the equipment has not been properly sanitised. Holding of the carcass for trimming at the warm slaughter room before final washing and chilling may allow for better attachment of bacteria (Reagan *et al.*, 1996). Trimming may facilitate bacterial penetration into carcasses.

Animals must be fasted to reduce gut contents to lower the risk of rupturing the digestive tract during evisceration, which would cause contamination of carcass with digesta and faeces (Gregory, 1998). Animals must be presented in a clean condition as stock which are dirty with dung, mud or dust on their surface create the risk of spreading dirt (Gregory, 1998). If dirty carcasses enter the dressing area, the veterinarian or supervising meat hygiene officer may be obliged to stop or slow the line in order to ensure either that the dirty carcasses are handled appropriately and do not contaminate equipment or other carcasses, or that further dirty stock do not enter the killing floor (Gregory, 1998).

1.3 ANIMAL WELFARE

Control of diseases in animals destined for human consumption is important for animal welfare in addition to its importance for food safety and profitability. Meat consumers have shown an increasing level of concern about the welfare implications of animal production systems over recent years. For ethical reasons alone, production animals should have as high a quality of life as possible, and certainly any treatment that may cause suffering is unacceptable. Preslaughter handling of animals and birds has a profound effect on the quality, and therefore, value of the meat (Varnam and Sutherland, 1995). Between farm and slaughter, cattle are subjected to transportation, confinement, unfamiliar surroundings and additional handling. Collectively or separately, these and other factors can constitute preslaughter stress.

Stress is an imprecise term, but it can be defined as an animal's response to any demand made upon it (Shorthose and Wythes, 1982). This definition is all-inclusive and implies that every demand made upon an animal causes a stress-related response. This is not necessarily true and therefore stress needs to be further defined. It can be described as an animal's response to conditions or factors that challenge its normal state of being. In animal husbandry, stress has usually been explained as a reflex action that occurs when animals are exposed to adverse conditions, and which is the cause of many unfavourable consequences, ranging from discomfort to death (Dantzer and Mormede, 1983). Moberg (1996) described stress as simply the biological responses that an animal uses to defend its homeostasis or biological status quo, from both external and internal challenges (or stressors). However, stress jeopardizes the animal's welfare only if it results in some

significant biological cost to the animal that places that individual's well-being at risk (Moberg, 1996). Dantzer and Mormede (1983) suggested that stress occurs when an animal has been exposed to adverse conditions. This could be interpreted as only external or environmental conditions such as, weather extremes. The use of "internal and external challenges" in Moberg's (1996) definition makes clear the possibility of stress being linked to environmental and internal stressors. Moberg (1996) also stressed that animal welfare is only jeopardized if stress results in significant biological cost to the animal.

Stress in the preslaughter period leads to increased defaecation and contamination of the bodies of animals and birds, resulting ultimately in an increased risk of contamination of the meat (Varnam and Sutherland, 1995). The incidence of *Salmonella* in pigs and poultry can increase considerably under these conditions. It has also been suggested that stress can lead to shedding of *Escherichia coli* O157:H7 by cattle which had previously tested as non carriers (Varnam and Sutherland, 1995).

One of the consequences of poor welfare associated with disease is that resistance to other disease is reduced (Fraser and Broom, 1990). Disease is one of the most important causes of animal suffering (Gregory, 1998). Animals that are diseased very often have difficulty coping with their environment, or fail to do so; hence their welfare is poorer than that of a healthy animal in otherwise comparable conditions (Fraser and Broom, 1990). Whether the disease causes pain or other kinds of discomfort or distress, treatment, which reduces the effects of the disease, is clearly improving the welfare or the animal (Fraser and Broom, 1990).

Coccidiosis is a protozoan disease of fowl and is a problem in all poultry-producing areas that has serious animal welfare implications. Despite recent advances in control and treatment, the disease remains one of the principal causes of economic loss to the poultry industry.

An understanding of the behaviour of animals will facilitate handling, reduce stress, and improve both handler safety and animal welfare (Grandin, 1989). 'Behaviour' is a term used widely in many sciences. Kilgour and Dalton (1984) describe behaviour as the patterns of action observed in animals that occur either voluntarily or involuntarily. An

animal's behaviour provides information on a wide range of factors such as breathing, eating, drinking, fighting, mating and milking (Kilgour and Dalton, 1984). Fraser and Broom (1990) suggest that farm animal behaviour research is relevant and necessary for animal production enterprises to be carried out effectively and economically. Observations of external behaviour can often lead to deductions about the internal state of the animal (Kilgour and Dalton, 1984).

1.4 OBJECTIVES

The overall objective of this work was to investigate approaches to improving food safety through preslaughter manipulation of gut microorganisms in cattle and chickens. Specific objectives were:

- To assess the effect of preslaughter feeding system on gastro-intestinal and faecal *Salmonella* and *E. coli* in steers and heifers.
- To measure the effect of preslaughter diet on faecal consistency and dry matter of the gastro-intestinal contents and faeces of steers.
- To determine the effect of preslaughter diet on the weight of contents in the gastro-intestinal tract of steers.
- To evaluate the effect of preslaughter feeding systems on weight loss in steers and heifers.
- To assess the effect of rearing chicks in the presence of adults on their ability to withstand *Eimeria tenella* infection.
- To determine the effect of growing environment on the weight of chicks before and after infection with *Eimeria tenella*.
- To evaluate the effect of rearing chicks in the presence of adults on their responses to a fearful situation.