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BULLETIN

Pre-slaughter Animal Management for Welfare and Production

This bulletin addresses aspects of stress in farm animals, and why it is important in animal production. Focus is on the critical pre-slaughter period. Methods of animal management that minimize stress for optimal welfare and production are discussed.

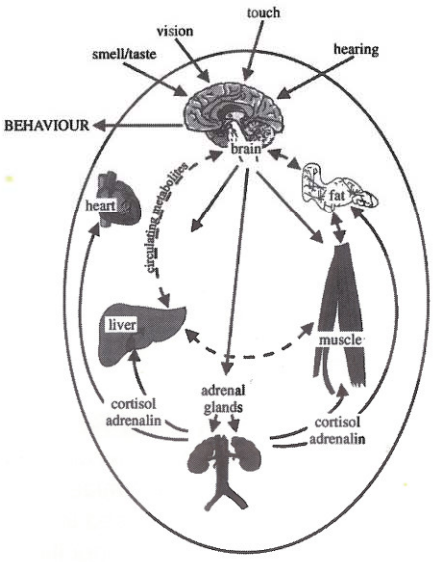
STRESS - WHAT IS IT?

In essence, stress is an animal's response to conditions or factors that challenge its normal state of being.

The factors that cause stress responses are termed "stressors". Stressors can be physical, such as environmental temperature extremes, illness, pain, and nutritional inadequacies; or they can be psychological such as fear and anxiety.

Stressors may be either short term (acute), or act over a longer time frame (chronic).

Once an animal encounters a stressor, it sets into action a coordinated chain of responses that involves its entire body. The senses (vision, smell, touch, hearing, and taste) provide information to the brain.



Acute stress affects many systems in the body.

The brain then processes the information: it recognizes a stressor, organizes an appropriate response and learns from the stressor/response. The brain does this through nerves and nerve communication chemicals called "neurotransmitters". These chemicals act within the brain and on glands to release hormones, such as adrenalin and cortisol, into the blood.

Adrenalin increases heart rate and blood pressure, and causes energy stores (both fat and carbohydrate) in the body to be mobilized. Cortisol causes further release of energy stores from muscle and fat, and promotes a general phase of "energy source readiness", rather than "energy storage".

The animal is then ready to flee from the stressor, or fight it– depending on which is the more appropriate response. The brain decides what type of behaviour is appropriate under the circumstances.

The physiology of the stress response is more complicated than expressed here. Other hormone systems may be integrated into the response, and these, in addition to adrenalin and cortisol, may affect other systems within the body, such as the immune system, reproduction and growth.

The stress response is therefore an adaptation that animals need in order to survive. However, if stress responses are inappropriate or excessive, the response in itself may compromise the animal's well-being and result in losses in production and meat quality.

HOW IS STRESS MEASURED?

Stress in animals can be studied in many ways.

Brain Neurotransmitters

It is possible to "eavesdrop" on the chemical processes in the brain. For example a probe can be surgically inserted into areas of the brain. Such a probe allows monitoring of the neurotransmitters that are involved in processing stress and bringing about resultant behaviour. Different types of neurotransmitters, in varying amounts, can be released in response to different stressors.

Research using these techniques has shown that individual animals within a species also release quite different types of neurotransmitters in response to stress (that is, they give an individual response to stress). This is important because it means we cannot treat all animals, even within the same species, in the same way if we want the best production and welfare.

Blood Hormones

Stress responses can also be monitored by analysing samples of blood for concentrations of stress-related hormones, such as cortisol and adrenalin.

In theory, levels of these hormones reflect the intensity of the stress response. In practice, however, these hormones may be cleared quickly from the blood, and may be preferentially released depending on the type of stressor and response.

Blood Metabolites

Blood samples can also be analysed for the metabolites released into the blood in response to the stress hormones cortisol and adrenalin. These include the blood- borne forms of energy stores and their breakdown products– carbohydrate (glucose and lactate), fat (fatty acids) and protein (amino acids and urea).

Animal Physical Response

Stress hormones cause heart rate and blood pressure to rise, and these changes can also be measured. Physical readiness induced by the stress response may also involve muscle tension (for movement or fighting). This can cause changes in blood circulation and increases in body temperature that can be measured as well.

Animal Behaviour

The behaviour of the animal will reflect stress as well. Behavioural changes may be obvious, such as a startle responses, fleeing or attacking, or may involve subtle changes in patterns of normal behaviour such as changes in the patterns of grazing, social interactions, sleeping and ruminating. All of these changes can affect production.

Many other aspects of animal physiology can be affected by stress, and hence measured. However, it is important to be aware that stress has body-wide effects, and measurement of any single parameter may not accurately reflect the whole animal response to a stressor. Assessment of multiple parameters improves the accuracy of determining the magnitude and importance of a stressor on an animal's well-being and productivity.

WHY IS ANIMAL STRESS IMPORTANT IN FARMING AND MEAT PROCESSING?

Welfare

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.

Stress can compromise animal welfare when stress responses are inappropriate or excessive, causing pain, anxiety, weight loss, immune failure (predisposing to illness), poor reproductive performance and in extreme situations, premature death.

Consumer concern for the well-being of animals is a powerful force in the market place.

For example, in 1995, there were about 160 animal welfare pressure groups in the U.K., many of which aim to influence consumer buying patterns. Correspondingly, in 1996, UK consumers were prepared to pay up to 14% more for products with advertised welfare quality control criteria.

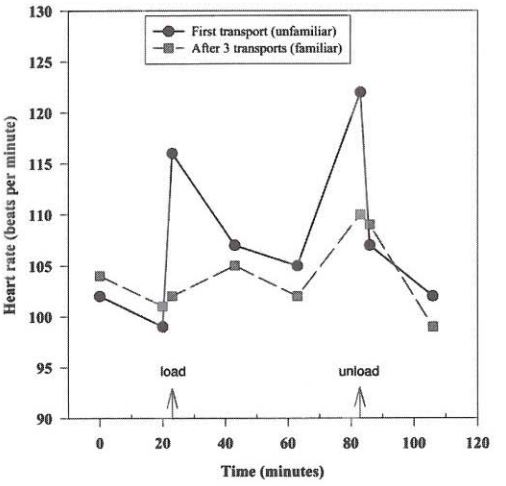
Thus, meeting welfare-friendly criteria may help to maximize returns. Also, failure to recognize the importance of consumer opinion overseas may give grounds for trade barriers.

Production and Meat Quality

In addition to welfare concerns, stress can affect productivity. Chronic (long term), excessive stress can reduce growth rates and immune function; acute (short term) stress may also affect productivity, though both meat yield and meat quality.

Excessive acute stress can result in dramatic increases in the metabolism of energy stores in the liver, fat deposits and muscle. In production terms, such stress just before slaughter, without adequate time for replenishment of these stores, can result in losses in carcass weight.

Acute stress just before slaughter can also affect meat quality, mainly by causing muscle glycogen (a carbohydrate store) to be broken down. In situations of oxygen deficit (as is the case after slaughter), glycogen is converted to lactic acid. The gradual build-up of this acid after slaughter causes the muscle pH to fall, as muscle turns into meat.



An increase in the heart rate of calves during transport reflected a stress response, which was subsequently reduced by familiarization.

The amount of glycogen in the muscle limits the ultimate pH (acidity) reached by the meat.

- If glycogen levels are very low as a result of excessive stress before slaughter, the meat pH will be high (6.0-7.0). As a result, meat colour will very dark (beef will be purple/brown), the meat will spoil quickly, and when cooked it will have a reduced meaty flavour and odour, although it remains relatively tender. Meat of this type is known as dark-cutting, or DFD (dark-firm-dry), and is unsuitable for table, or prime, meat markets.
- Meat with a lesser glycogen depletion will have a moderate pH (5.7-6.0). Such meat has a lesser colour defect (beef will be dark red), and slightly improved storage characteristics and flavour on cooking, but tends to be unacceptably tough.
- The best quality characteristics are shown by meat with minimal glycogen depletion. Its ultimate pH will be around 5.5– its colour is good (beef will be bright red), and its storage life is greatly improved compared to DFD meat. Its eating quality is also ideal.

ACUTE STRESS IN THE PRE-SLAUGHTER PERIOD

If we are to be able to minimize pre-slaughter stress, we need to identify potential stressors specific to this period. We can then

develop techniques that will either eliminate unnecessary stressors, or minimize the effect of stressors on the animals.

Social Stress

One potential stressor in the pre-slaughter period relates to animal social interactions. Cattle and sheep develop well-established dominance hierarchies in the field. Close confinement of the animals, even if they remain as a stable group, can activate social conflicts. This can be seen when animals are held in yards and animals of different ranks within the hierarchy come into contact with each other.

Disruption of an existing hierarchy causes greater social stress, especially when combined with confinement. Drafting a mob of animals from a stable herd or flock can cause social conflict, even though the animals are familiar with each other, as hierarchies are re-established.

Mixing unfamiliar animals before slaughter is likely to result in extreme social disruption and stress. A good example is mixing bulls pre-slaughter, which results in increased fighting and mounting activity. Both the increased muscle activity and the stress response can deplete muscle glycogen and result in high pH meat. This type of behaviour is also particularly important from a welfare perspective, as fighting and mounting animals can become physically exhausted and injured.

Cattle maintained in socially stable groups throughout the pre-slaughter period are less likely to encounter extreme social stress than drafted mobs from the same social group, or, especially, animals mixed from unfamiliar social groups.

Unfamiliar Procedures, Fear and Anxiety

In addition to social stressors, other events in the pre-slaughter period can cause considerable stress responses. These events include mustering, contact with dogs and people, loading and unloading from transport, transport itself, and the meat plant environment.

The common characteristic in all these events is unfamiliarity, with the possible exception of dogs, for which most livestock have an instinctive dislike. Unfamiliarity is likely to cause stress responses in domestic livestock through fear of the unknown and resultant anxiety.

Familiarizing animals with pre-slaughter procedures, or aspects of these procedures, may reduce subsequent stress responses considerably.

As an example, farm management systems, such as rotational/strip grazing, with regular runs through yards for non-invasive procedures such as weighing, can promote familiarity.

It is important to ensure that the animals have minimal unpleasant experiences during these familiarization periods. The aim of familiarization is to reduce fear of the unknown by allowing animals to learn there is nothing to fear. This aim will be compromised if the animals' experiences with these factor are unpleasant. It is important to remember that some animals, particularly cattle, are curious, and allowing some time for investigation can be helpful in advancing familiarisation.

Handling Facilities and the Herding Instinct

Even if animals are familiar with the process of mustering and being moved through yards and races pre-slaughter, these experiences can still produce stress responses. Such stress can be minimized by being aware of, and making use of, the strong herding instinct of most domestic livestock.

Separating individuals or small groups from a larger group of animals can cause the separated animals to panic. In contrast, allowing animals to follow one another reduces stress responses, and the animals are far easier to move, as well.

Yards and races can be designed to facilitate this desirable "following" behaviour, for example, by using curved races and yard walls. Yards with 90° angled corners can cause animals to stop in those corners.

Races with solid walls encourage animals to move along the course of the race, rather than being distracted by viewing other animals through the race walls.

Transport

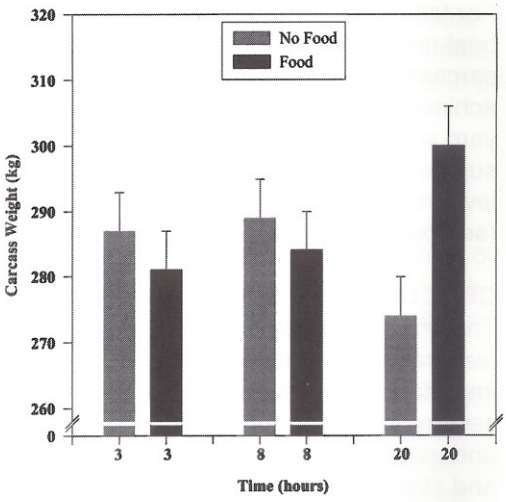
Transportation is another stressor in the pre-slaughter period. Studies have shown that heart rate peaks during loading and unloading (refer to figure opposite page), and that the overall transport process increases both the concentration of circulating stress hormones and body temperature. Again, familiarity with yarding, races and loading ramps can facilitate the loading procedure, reducing overall stress responses to transport.

The density of animals in each pen on the transporter should aim to minimised falls and trampling without overloading. Extremes of density (too cramped or too loose) can result in stressful difficulties loading and unloading, and animal bruising or overheating.

Careful driving and transportation of only healthy stock will help to ensure that stock arrive at the meat plant in best condition.

Feed and Water

An additional stressor common to the pre-slaughter period is depriving animals of feed and water. The time spent off feed may include that during yarding before transport,



Carcass weights of tail-gate slaughtered bulls held pre-transport, with and without food, for 3, 8, or 20 hours.

transport itself, and over lairage at the meat plant.

Combined holding periods and transport can result in fasting periods ranging anywhere from a couple of hours to a day or two. One study found that fasting 2 year old bulls over one full day reduced the carcass weights by 25-40 kg (see bar graph, previous page). Withholding water for this time seriously compromises welfare, and results in considerably greater losses in carcass weight.

Water should be available throughout all holding periods (pre-transport and after transport). Minimum standards for adult ruminants advocate watering at least every 12 hours.

Frequency of Stressors

Research investigating the stress responses of cattle to components of the pre-slaughter period found that the rate of incidents of stressful events greatly affects the animals' stress responses and carcass weights.

Animals given time to recover between each step of the pre-slaughter processes seemed to cope better than those that were not given time. For example, holding animals in yards for up to 20 hours between muster and transport decreased stress responses to transport compared with animals held for just 3 or 8 hours. It must be remembered, however, that fasting for long periods will reduce carcass weight.

For tail-gate slaughtered bulls, the best results in terms of both carcass weights and welfare were achieved with 20 hours holding in yard with provision of a familiar supplement given at two times the level required to maintain liveweight (see bar graph, previous page).

CONCLUSIONS

The effect of stress on animal welfare and production has important implications for all sectors of the community. A fuller understanding of animal behaviour and stress responses can be used to develop practical methods for minimizing stress, particularly in critical production procedures such as the pre-slaughter period.

IN SUMMARY

The treatment of animals before slaughter can affect their welfare, carcass yield and meat quality; management of animal stress in the pre-slaughter period can minimize these losses:

Prior to the Pre-Slaughter Period

Organize pre-slaughter procedures well in advance, to ensure smooth operation.

Minimize disruptions to social groups. Running animals in stable groups through to slaughter gives stable hierarchies and minimizes social conflict.

Use good race and yard design (on-farm and at meat plants) to facilitate stock movement.

Use farming systems that allow animals the opportunity to become familiar with procedures and facilities, to help reduce acute stress before slaughter.

During the Pre-Slaughter Period

Accomplished stockmanship skills are essential, with minimal use of dogs and goads.

Maintain animals in stable social groups throughout all pre-slaughter processes (on-farm holding, transport and lairage).

Spread out incidents of pre-slaughter processes to allow animals to recover between each potentially stressful incident.

Avoid extended periods of fasting, to protect carcass yield and buffer against glycogen losses. Use familiar feed supplements. Water should be freely available during pre- and post-transport holding periods.

Try to minimize the length of transport when possible. Transportation and holding that keeps animals from water for more than 8 hours, or feed for 24 hours, can seriously compromise welfare and productivity.

Load animals to optimum density on transporters, and drive carefully.

Transport only healthy animals.

FURTHER READING

Cook, C.J. (1996) Talking to the animals. *N.Z. Sci. Monthly,* March, pp 8-9.

Cook, C.J. (1997) Real-time measurements of neurotransmitters in conscious sheep. *J. Neurosci. Methods* (in press)

Cook, C.J. & Jacobson, L. M. (1996) Heart rate as a measure of adaptation to stress in cattle. *Aust. Vet. J.*, **74**(6), 471-472.

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