Monitoring stress hormone metabolites as a useful, non-invasive tool for welfare assessment in farm animals

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Abstract

A multitude of endocrine mechanisms are involved in coping with challenges. Glucocorticoids, secreted by the adrenal glands, are in the front line of the battle to overcome stressful situations. They are usually measured in plasma samples as parameters of adrenal activity and thus of disturbance. Unfortunately, collecting blood samples itself can disturb an animal. Thus, non-invasive methods for the determination of glucocorticoids or their metabolites have become increasingly popular. The pros and cons of various non-invasive sample materials (saliva, excreta, milk, hair/feathers and eggs) for glucocorticoid determination are given. Above all, faecal samples offer the advantage that they can be collected easily. In faecal samples, circulating hormone levels are integrated over a certain period of time and represent the cumulative secretion of hormones. Thus, the levels are less affected by short fluctuations or the pulse-like nature of hormone secretion. However, using this technique to assess an animal’s adrenocortical activity is not especially simple. Whether frequent sampling is necessary or single samples will suffice depends upon the study’s aim (whether one is examining the impact of acute or chronic stressors). Background knowledge of the metabolism and excretion of cortisol/corticosterone metabolites is required and a careful validation for each species and sex investigated is obligatory. The present review also addresses analytical issues regarding sample storage, extraction procedures and immunoassays and includes a comprehensive list of published studies (up to 2011) describing the use of such methods in farmed animals. Applied properly, non-invasive techniques to monitor glucocorticoid metabolites in faecal samples of various species are a useful tool for welfare assessment, especially as they are easily applied at farm or group level.

Keywords: animal welfare, corticosterone, cortisol, faeces, farm animals, stress

Introduction

In recent years, there has been growing interest in and concern about animal welfare. However, the assessment of animal well-being is a complex matter (Rushen et al 2011). Although good welfare is more than the absence of stress, stress plays an important part in welfare research (Broom 2001). The most often used nomenclature defines environmental stimuli that lead to an imbalance of homeostasis as ‘stressors’ and the corresponding defence reactions of an animal as ‘stress responses’ with the brain having the central role in linking stressors to responses (Möstl & Palme 2002). Responses include behavioural changes, changes to the immune system, and activation of the neuroendocrine system (hypothalamic-pituitary-adrenal [HPA] axis) and the autonomous nervous system (ANS), Moberg (2000). The range and complexity of changes can differ markedly between species, individuals and stressors and can vary according to prior experience and stage of life history (Cook et al 2000; Sheriff et al 2011). It is important to note that stress responses are not inherently bad as they help an organism to cope with its environment and challenging situations. However, if activated too much or for too long some may have detrimental effects on the organism, resulting in impaired biological functions (eg reproduction, immunity and growth; Moberg 2000).

Evaluating stress responses — HPA axis

As activation of stress responses is context dependent (eg the HPA axis may be activated during beneficial or detrimental circumstances), measurement of a single parameter alone may be misleading (Broom & Johnson 1993; Rushen 2000). Thus, it is common consensus that a combination of different measurements (eg physiological and behavioural) for evaluating stress should be considered (Rushen et al 2011). Catecholamines and glucocorticoids (secreted by the medulla and cortex of the adrenals, respectively) are released within seconds to minutes after a stressor. They are front-line hormones in the battle to overcome stressful situations. Both hormones are quickly metabolised and excreted via urine and faeces (El-Bahr et al 2005; Palme et al 2005; Lepschy et al 2008). Urinary catecholamine metabolites were measured in farm animals (eg Hay & Mormède 1998). However, activity of the ANS can be evaluated indirectly by heart rate (variability). This