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Techniques for Behavioural Tracking and Welfare Evaluation of Poultry

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Poultry is commercially raised globally for egg and meat production, and advancements in genetics, nutrition, and management have significantly enhanced productivity in recent years. Nonetheless, these innovations and methods do not consistently align with the inherent needs of the birds, thereby compromising their wellbeing. The public has consistently expressed concern about the conditions in which animals and birds are kept, necessitating the development of procedures to establish minimum welfare standards for poultry. The behaviour of poultry reflects their welfare condition at a specific time, and its precise interpretation, encompassing frequency, length, and sequence, can be utilized to assess their welfare. Various approaches, both conventional and contemporary, have been developed throughout the years to monitor the behavioural responses of chickens to evaluate their welfare condition. This article aims to elucidate scientific methodologies that document various poultry behaviours, correlate them, and evaluate avian welfare through both manual techniques and contemporary technologies.

Keywords: assessment; behaviour; freedom; poultry; welfare

Introduction

Poultry is among the rapidly expanding sub-sectors of agriculture in India, with an annual growth rate of 6-8% in broiler meat and 5-7% in egg production (Bhanja, 2016). The increase in production during a brief timeframe is attributable to advancements in animal genetics, nutrition, and management approaches. Within the livestock sector, poultry has emerged as the most efficient provider of high-quality protein to customers globally. Nevertheless, these innovations and methodologies do not consistently align with the inherent requirements of the avian species. In intensive poultry production, numerous factors, including high stocking density, environmental degradation, inadequate social conditions, thermal stress, and challenges in obtaining essential resources, can significantly contribute to stress, resulting in compromised welfare and diminished performance (Appleby et al., 1993; Meluzzi and Sirri, 2009). The public's growing concern over the conditions under which birds and animals are kept has made it necessary to adopt strategies to ensure basic standards for animal welfare. The World Organization for Animal Health (OIE, 2011) asserted that an animal is in a satisfactory state of welfare if, according to scientific evidence, it is healthy, comfortable, well-nourished, secure, capable of exhibiting innate behaviours, and free from adverse conditions such as pain, fear, and distress. Poultry producers must comprehend the impact of production systems on avian welfare and endeavor to create systems that facilitate the expression of inherent behaviours in birds. Poultry behaviour reflects their wellbeing condition at a specific instant and is influenced by internal (physiological) and external (environmental) elements. The precise analysis of poultry actions, encompassing their

frequency, duration, and sequence, might be utilized to assess their welfare. In ethology, the manifestation of innate behaviour is frequently employed as a metric to assess poultry welfare. Welfare relies on effective management techniques and the utilization of appropriate equipment; various technology advancements are emerging to enhance these aspects.

Welfare assessment: principles, criteria and score calculation as defined by Welfare Quality Standards

The physical and psychological health of an animal influences its welfare, as encapsulated by the five freedoms of welfare (Brambell report, 1965):

- ✓ Freedom from discomfort: Ensuring a conducive environment for repose.
- ✓ Freedom from hunger and thirst: Immediate availability of fresh sustenance and water to sustain optimal health and vitality.
- ✓ Freedom to express natural behaviour: Ensuring adequate space, suitable amenities, and companionship of conspecifics.
- ✓ Freedom from pain, injury, and diseae: Prevention, diagnosis, and management of diseases.
- ✓ Freedom from fear and distress: Establishing conditions and interventions to prevent psychological misery.

Various welfare indicators can be employed to evaluate welfare, including health (morbidity, mortality, and injuries); physiological stress responses (body temperature, hormone and enzyme levels, respiration rate); management practices (raising system); and, finally, meat quality. Among various signs, behavioural responses are the most pertinent measures of an animal's well-being. Assessing bird welfare through monitoring entails several experimental assessments, including rearing techniques and the documentation of specific reactions, such as vocalizations and postural displays. The assessment of welfare will only be agreed upon and recognized by the academic community through a multidisciplinary approach due to its complexity.

Welfare Quality® assessment standards

Welfare Quality has established a framework for comprehensive evaluation of welfare and standardized conversion of welfare metrics into summary data. The welfare evaluation of an animal unit is predicated on the computation of welfare ratings derived from gathered information. Welfare Quality® researchers engaged with experts, including animal scientists, social scientists, and stakeholders, to refine the methodology and criteria for comprehensive evaluation and grading in alignment with expert consensus. The data generated by the measures pertinent to a certain criterion are analyzed and integrated to yield a criterion score that indicates the animal unit's adherence to this criterion. Compliance is quantified on a scale from 0 to 100, with 0 representing the lowest welfare, 50 indicating neutrality, and 100 denoting optimal welfare ratings.

Table 1: Welfare Quality® assessment standards (De Jong and Guemene,2011**)**

Welfare principles	Welfare criteria	Measures
Good feeding	1. Absence of prolonged hunger 2. Absence of prolonged thirst	Criteria measured at Abattoir Drinker space
Good housing	3. Comfort around resting 4. Thermal comfort 5. Ease of movement	Plumage cleanliness, litter quality, dust sheet test Panting, Huddling Stocking density
Good health	6. Absence of injuries 7. Absence of disease 8. Absence of pain induced by management procedures	Lameness, Hock burn, FPDOn farm mortality, culls on farm
Appropriate behaviour	9. Expression of social behaviours 10. Expression of other behaviours 11. Good human- animal relationship 12. Positive emotional state	Cover on the range, free range Avoidance distance test (ADT) Qualitative behavioural assessment

Welfare assessment via vocalization

The assessment of animal vocalizations may serve as a dependable indicator of their emotional condition or behavioural tendencies (Mulligan et al., 2002). The interpretation of animal vocalizations is a non-invasive and very objective technology. Recent research employing contemporary sound interpretation techniques incorporate numerical analysis in specific contexts, and when correlated with established parameters, may facilitate welfare assessment. Stressful settings may elevate the frequency of vocalization. Zimmerman & Koene (1998) found that female broiler breeders perform different afflictive cries when they cannot nest their eggs within three days.

Behavioural reflex: key correlation to assess welfare

In various circumstances, animals exhibit distinct options, and the level of stress displayed during these behavioural decisions may ultimately reflect their actual access to their needs (Dawkins, 2003). Video cameras can be employed for image-based recording to capture the behavioural responses of birds without disrupting their natural behaviour. Images can be utilized to construct temporal profiles of avian activity (movement, response to ventilation, huddling, etc.), as well as to compare activity levels throughout various regions of the facility. Developing non-invasive technologies for the measurement of behaviour and welfare, together with the associated methodology, is essential. Animal welfare has focused on recognizing adverse welfare states, including indicators of discomfort, tension, aggression, boredom, and abnormal behaviour, as the manifestations of poor welfare are more readily identifiable. Frustration, fear, and avoidance assessments have demonstrated significant utility in investigating the domain of inadequate welfare. Preference tests/choice experiments: Assessments of animal and avian welfare conditions have extensively employed tests for preferences, fear, avoidance, frustration, and operant conditioning approaches. The preference experiments are predicated on the premise that animals and birds, akin to humans, choose pleasurable experiences. Preference experiments can yield valuable insights into animals' subjective evaluations of environmental conditions on a theoretical welfare scale. Preference testing is widely regarded as an effective method for assessing particular environmental factors such as flooring, temperature, and lighting.

Types of behavioural observations

The sampling of birds' behaviour can be recorded by direct or indirect methods:

Direct observation: In practice, a human specialist must monitor animals and record their behaviour and interactions in real time. Direct behaviour observation and manual event recording give researchers maximal flexibility.This observation and scoring is subjective. Manual recording is time-consuming, biassed, and may miss essential behavioural responses when researching big flocks.

Indirect observation: Video-recording and other computer-assisted software have replaced pen-and-paper recording. It saves time. An automatic system records audio and video. Multiple viewings allow the observer to better understand the behaviour. No observer bias. This approach has a limited field of view, slow recording analysis, and birds need time to get used to the camera.

Behaviour categories: Determine behavioural categories before sampling. Behavioural categories include status and event behaviours. Resting, lying, standing, strolling, and investigating are long-lasting states. Events including feeding, drinking, fighting, preening, feather pecking, and dust-bathing are brief. To efficiently measure behaviour, we can discriminate between these because different measuring methods are employed for each type of behaviour.

Behavioural sampling methods

Behaviour can be recorded continuously or sampled at regular intervals, by individual or group, and grouped into several activities or a complete ethogram. When it is neither possible

or practical to continually watch and record all of an individual's or group's behaviour, sampling decisions are taken to obtain a partial record. The sampling methods are:

- *Adlibitum sampling*—The observer records what they see and consider relevant. Informal and unsystematic. It can create ethograms of rare yet important behaviours.
- *Scan/Instantaneous sampling*—a group is rapidly scanned at regular intervals and each subject's behaviour is recorded. The number of individual birds scanned and behaviours recorded determine the sampling interval. Behaviour and percentage of time are synchronized.
- *Focal/continuous sampling*—Examiners monitor a subject for a set duration and capture all relevant behaviour. Focal sampling is the best way to investigate groups since the observer focuses on one person and can accurately record behaviour frequencies and durations. It records behaviour impartially. Time %, length, nearest neighbor relationships.
- *All occurrence sampling*—This sampling approach is utilized for a single behaviour rather than an individual or group's total activity. The observer monitors all subjects and documents each behaviour in detail. Records of rare but important behaviours

Behaviour recording techniques

Once the sampling method is decided, the observer has to choose the appropriate behaviour recording method. There are two types of recording methods:

- Continuous recording captures all relevant behaviour units. give the most exact frequency, duration, and sequence data. Record events and states with it. It may be impractical or unreliable since the observer may miss other behaviours while documenting one.
- The observer records behaviour at the end of each small sample interval (sample point). It measures more categories and people. Time sampling approaches depict observable behaviour rather than its frequencies or durations. These methods are unsuitable for capturing sequences of behaviours because the observer only considers small sample intervals and records the animal's behaviour at those intervals.

Ethogram

One way to keep track of the many ways in which animals and birds go about their everyday lives is with an ethogram. One way to determine what kind of measurement is needed when making an ethogram is to categorize behaviours as either states or events. The production of an ethogram requires the meticulous recording of all behaviours exhibited by the animal(s) over a specific time period. Several preliminary observations, taken at various times and by different people, are necessary (Bhadauria and Bhanja, 2017).

Analyzing and interpreting behavioural data

The accurate analysis of poultry behaviours, encompassing their frequency, duration, and sequence, might be utilized to assess their welfare. The examination of behaviour is significantly enhanced by the utilization of mathematics and engineering techniques, such as modeling, artificial intelligence, remote behavioural detection approaches, operant equipment, and sophisticated statistics.

Automated methods and computer software for behavioural recording and welfare assessment of poultry

The optimal behaviour monitoring system must be fully automated, yielding objective and reproducible measurements with minimal human intervention. Numerous automated behaviour recording systems possess tools or software that streamline the data entry procedure and enhance the accuracy of the acquired data. Precision livestock farming (PLF) is described as the management of livestock production utilizing the ideas and technology of process engineering, relying on automatic data collecting, access, and processing (Wathes et al., 2008). Data from various sources are gathered via intelligent sensors and consolidated

into a central database, where they will subsequently be analyzed to develop an automated management system predicated on real-time monitoring to regulate animal performance, health, and welfare (Berckmans, 2014).

Several studies reported automatic behaviour recording methods include:

1. *Video cameras*- video cameras and information technology can improve animal behavioural response recording and analysis (Donát 1991). Recent technologies for automatic recording and assessment of poultry welfare include thermal imaging to assess distress in chickens, image analysis for young chick behaviour, and infrared thermography for heat loss (Ferreira et al., 2011).
2. *Environmental sensors*—Multi-sensing systems to monitor environmental temperature, differential indoor atmospheric pressure, and air velocity in broiler flocks automatically assess the ventilation system's design and functioning to provide a comfortable environment for poultry and improve bird welfare.
3. *Audio sensors*—Birds use audio communication and signalling for social interactions, alarm signaling, and stress indicators (Corkery et al., 2013), making them reliable welfare evaluation indicators. Numerous research have utilized acoustic softwares such as Raven, Adobe® Audition™ CS6, Cool Edit®, and Audacity® to evaluate poultry wellbeing (Fontana et al., 2015).
4. Freedom of mobility is essential to animal wellbeing. Piezoelectric crystal sensors assessed broiler welfare by measuring locomotor limitations. GIS sensors, 3 axis ADL335 accelerometers, and RFID transponders have been used to analyze bird mobility and welfare (De Jong et al., 2012).

Computer softwares for behaviour data analysis (Bhadauria and Bhanja, 2017):

- *JWatcher*-Designed for focal sampling. It calculates time budgets and offers behavioural state duration and interval information.
- *Solomon Coder*: Behaviour-coding program. It will display primary statistics from the coding sheet, such as frequencies, durations, and percentages.
- *BORIS* is event logging software for video/audio coding and live observations.
- *The Janelia Automatic Animal Behaviour Annotator (JAABA)* uses machine learning to automatically compute interpretable, quantitative information about animal behaviour in video.
- *Observer XT/Ethovision*: Noldus Information Technology, Wageningen, Netherlands, provides professional and user-friendly event logging software for collecting, analyzing, and presenting observational data that improves reliability analysis, audio input, and visualization

Conclusion

The welfare of poultry birds is a major societal concern and must be considered when raising them. Poultry behaviour reflects their welfare at a given time and is affected by physiological and environmental factors. Correct interpretation of poultry behaviours, including frequency, length, and sequence, can assess welfare. Modern poultry production equipment can automatically identify behaviour, health, and welfare. However, these automated techniques are limited to experimental conditions and require more research to commercialize.

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