Journal of Applied Veterinary Sciences, 11 (1): 76-85 (January, 2026).
ISSN: Online: 2090-3308, Print: 1687-4072
Journal homepage : https://javs.journals.ekb.eg

Application of the Welfare Quality® Protocol in Semi-arid Broiler Production Systems

BAA Abdelhamid* and BARA Yamouna
Department of Agronomic Sciences, Faculty of Sciences, Mohamed BOUDIAF University, M'Sila, Algeria
*Corresponding Author: BAA Abdelhamid, E-Mail : abdelhamid.baa@univ-msila.dz

ABSTRACT

The productivity, health, and meat quality of broiler chickens are all directly impacted by their welfare. This study aimed to assess the welfare of these animals. It was conducted on several farms in the M'Sila region of Algeria. The methodology adopted is that of the Welfare Quality® protocol (2009): a questionnaire, observations, and handling of the animals were carried out in 19 farms in the high-potential poultry farming area of the wilaya of M'Sila, comprising 71 standard buildings used for broiler chicken farming. The indicators studied relate to good housing (cleanliness of plumage, litter quality, dust test, thermal comfort, and density), good health (plantar pad dermatitis, hock burns), and human-animal interaction (touch test). The results revealed that 63% of the buildings were traditional, with 78.9% of farmers using the Cobb 500 strain. The quality of the litter in the buildings was acceptable (nearly 60% of cases received a score of 1), meaning that it was dry and difficult to move. The average feather cleanliness index was 99.51%. Low stocking density (13.94 ± 8.75 birds per square meter) and low dust levels were observed in all buildings. Grade 1 or 2 skin lesions were observed on the footpads of all subjects in 20% of the buildings, with no grade 3 or 4 lesions observed. Burns on the hocks were either absent (score 0) or minimal (score 1 or 2) in 76% of the buildings. Overall, it can therefore be concluded that the welfare of broiler chickens on the farms visited was satisfactory.

Keywords: Chicken, Cleanliness of plumage, Footpad dermatitis, Living conditions, Stocking density, Welfare Quality.

Original Article:
DOI:https://doi.org/10.21608/javs.2025.436536.1809
Received : 27 October, 2025.
Accepted: 13 December, 2025.
Published in January, 2026.

INTRODUCTION

Poultry farming is strategically positioned in global agriculture due to its economic significance and major contribution to food **security (Singh *et al.*, 2022; Birhanu *et al.*, 2023).** In 2023, global poultry meat consumption amounted to 139 million tons, surpassing beef (74 million tons) and sheep and goat meat (17 million tons). This demonstrates a notable shift towards poultry as the dominant source of animal protein. OECD/FAO estimates indicate that this trend will persist, with a projected 15% increase by 2033. The growth in poultry meat demand is a key driver, expected to comprise 55% of the overall increase. A global poultry meat production overview reveals the substantial influence of specific regional markets. China holds the top position with 24.41 million tons (MT), followed by the United States (23.31 MT), Brazil (15.25 MT), and the European Union (13.49 MT). While ranked fifth, Africa, with 6.93 million tons, shows increased growth momentum, particularly due to accelerating demand within the continent **(OECD/FAO, 2024).** In Algeria, the poultry sector has one of the most impressive growth rates in livestock production. With an estimated domestic poultry meat production of 421,271.41 tons in 2023 **(FAO, 2025).** It is a cornerstone of the Algerian agri-food system after the cereal and dairy sectors **(Ferrah *et al.*, 2024).** To meet growing local and international demand, considerable efforts are being made to maximize profitability while maintaining high quality standards.

Introducing modern practices in key areas of livestock farming, such as specialized feed, optimized animal health, and improved farm infrastructure, is essential to balancing production costs with price competitiveness in the market. Rigorous management of the production chain also implies a transition to improved animal welfare practices.

In recent years, animal welfare has become an increasingly central concern for farmers and consumers **(Garreta and Orain, 2019).** The widely accepted framework for defining this concept is based on the "five freedoms": freedom from hunger, thirst, pain, disease, and fear or stress; and freedom to express natural behaviors specific to their species. These aspects

are not simply ethical requirements but also levers for improving productivity and meat quality. Algeria has significant potential to transform its poultry sector by adopting modern and sustainable practices. The strong demand for animal protein, combined with modern consumers' desire for healthier and more ethical food, creates a strategic positioning opportunity.

This study aims to assess the extent to which poultry farming practices in the M'Sila region comply with established welfare standards for broiler chickens. The indicators examined include good housing practices (e.g. plumage cleanliness, litter quality, dust levels, thermal comfort, and stocking density), good health practices (e.g. plantar pad dermatitis and hock burns), and human-animal interaction practices (e.g. touch test).

MATERIALS AND METHODS

Sites and farms visited

The most productive poultry farms (broilers, laying hens, and turkeys) are primarily located in the northern municipalities of the province (e.g., Magra, Berhoum, Maadid). On the other hand, the southern towns have steppe pastures that are mostly used for raising ruminants, especially sheep, goats, and camels (**DSA, 2023**). This study aims to evaluate the welfare of broiler chickens in the M'Sila region of Algeria using the Welfare Quality® assessment protocol, focusing on housing conditions, health indicators, and environmental management across 19 farms. These farms are located in the aforementioned northern region and are distributed across the nine municipalities shown in **Fig. 1**.

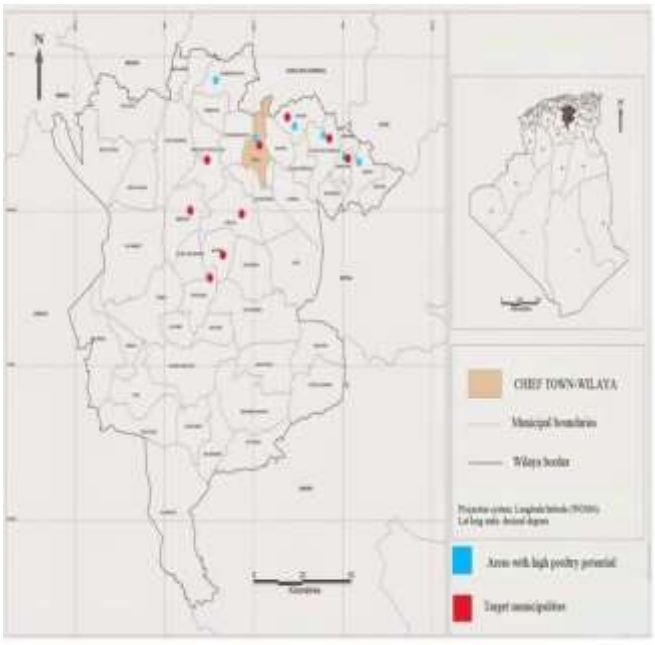

Fig 1. Map of the M'Sila province and 9 target municipalities

These farms were subject to field inspection, monitoring, and evaluation between April and May 2023. This study uses the Welfare Quality® assessment protocol to evaluate the welfare of broiler chickens in the M'Sila region of Algeria. The Welfare Quality® framework provides a standardized approach to assessing these dimensions in livestock systems. The study focuses on housing conditions, health indicators, and environmental management across 19 farms. These farms are located in the aforementioned northern region and are distributed across the nine municipalities shown in **Fig. 1**. The farms were inspected, monitored and evaluated between April and May 2023.

Measurements taken

Field survey

The survey collected data on the number and type of buildings, the breeds of animals raised, the number of animals per building and pen, their age and weight at slaughter, and the type and composition of feed provided. This information was obtained from farmers' records or declarations.

Welfare assessment

The Welfare Quality ® (2009) scoring scales are adopted as follows **(Butterworth , 2019):**

Good accommodation

Cleanliness of plumage

A sample of 100 birds was examined at ten different locations in the poultry house, chosen at random. The birds were placed in a capture pen and then assessed according to the above-mentioned protocol, with a score assigned on a scale from 0 to 3 **(Butterworth, 2019):**

0: very clean plumage;
1: clean plumage
2: moderately dirty plumage
3: very dirty plumage

Formula for the cleanliness index:

$$CI = \left[100 - \frac{2\,(\%\,\textbf{slightly dirty}) + 7\,(\%\,\textbf{moderately dirty}) + 13\,(\%\,\textbf{dirty})}{13}\right]$$

Litter quality

The quality of the bedding was assessed in five locations within the chicken coop: near the watering points and feeders, by the doors, and in the center of the structure. According to the protocol, litter quality is classified according to the following 5 scores **(Butterworth , 2019)**:

0: litter completely dry and flaky, easily moved with the foot;
1: litter dry but not easily moved with the foot.
2 : litter that leaves footprints and forms a ball when compacted, but the ball does not hold together well.
3 : litter that sticks to boots and easily forms a ball when compacted.
4 : litter that sticks to boots once the compacted crust is broken.

Dust test

The test consists of a visual assessment carried out using a sheet of black A4 paper, placed horizontally near the entrance door and away from the animals. The visit must last 3 hours. At the end, the level of dust on the paper was classified as follows **(Butterworth, 2019):**

0: No dust, all of the black paper visible
1: Little dust, thin layer of dust
2: A lot of dust, but black paper visible
3: Colour of paper not visible

Thermal comfort assessment

Panting and Hudding up

At five randomly selected locations in a poultry house, panting (an indicator of heat stress) and shivering (an indicator of an excessively cold environment) are to be determined for each sample of 100 birds.

Assessment of ease of movement (bird density)

The density was calculated by dividing the number of birds present by the surface area of the building in square meters.

Good health

Dermatitis of the footpad

Footpad dermatitis was assessed at ten locations within a poultry house, with 100 birds examined as a sample. Each bird's two feet were examined, and a score was assigned based on which foot displayed the most severe symptoms. The scores were classified into the following categories:

a) no signs of footpad dermatitis (score 0);
b) minimal signs of footpad dermatitis (scores 1 or 2);
c) presence of footpad dermatitis (scores 3 or 4).

Burn on the hock

A sample of 100 birds was examined at ten locations throughout the poultry house. Both hocks were inspected and scored based on the most severe findings. The presence and severity of burns on the hocks were assessed using a 0–4 scale **(Butterworth, 2019)**. The scores were recorded as follows:

a) No signs of hock burns (score 0),
b) Minimal signs of hock burns (scores 1 and 2)
c) Evidence of hock burns (scores 3 and 4).

Human-animal relationship

Touch test

We approached a group of at least three birds in the litter area, then crouched down for ten seconds. We then counted the birds within reach, i.e. less than one meter away. Any attempt to approach a group of birds, even if all the birds withdrew from our presence, was considered a trial. This operation was carried out 21 times at different locations in the henhouse. The number of birds within reach was recorded for each trial **(Butterworth, 2019).**

Statistical analysis

The survey data was analyzed using *IBM SPSS 26* software. Basic descriptive statistics (means, standard deviations and proportions) were calculated for each parameter, and graphical representations were created to visualize the data more clearly.

RESULTS

General description of farms

Out of the farms visited, 78.9% used the Cobb 500 strain, followed by the Arbor Acres strain at 21.1%. Farmers' purchasing strategy is to choose from the available strains on the market, favoring the lowest price. Nevertheless, these two strains have proven well suited to the region's climate and offer exceptional yields and high disease resistance.

On average, the farms visited had 12,881 birds per farm, ranging from a minimum of 2,600 to a maximum of 67,000. Most of the livestock buildings are traditional, representing 63% of the total. Greenhouses and cinder block sheds converted into chicken coops also represent 63% of the total. These buildings have concrete floors covered with a thick layer of wheat straw and are naturally ventilated. While this is more economical, it negatively affects the welfare of the chickens. Only 37% of farmers use modern buildings equipped with climate control systems, such as mechanical ventilation, artificial lighting and automated feeding, watering and manure management systems.

During our visits, 52% of farms were in the finishing phase of the rearing cycle, 31% were in the growing phase and 15% were in the starter phase. The average age of the pigs was 30.79 ± 13.99 days. The average slaughter weight was 3.33 ± 0.38 kg. Weights ranged from a minimum of 2.7 kg to a maximum of 3.8 kg. The animals are fed standard commercial feed made from corn and soybean meal; the exact composition varies depending on the rearing stage.

Animal welfare assessment

In order to address the concept of well-being in all its aspects, it was necessary to work on all stages of the rearing cycle, including the start-up phase (on 16%), the growth phase (on 32%) and the finishing phase (on 52% of farms).

Litter quality

Only 5.26% of broiler poultry farms received the top score of 0, indicating that the litter was completely dry and flaky and could easily be displaced

by foot. In contrast, 60% received the lowest score of 1 **(Fig. 2).** Poor litter quality was indicated by scores of 2 and 3, which were assigned to 36% of buildings.

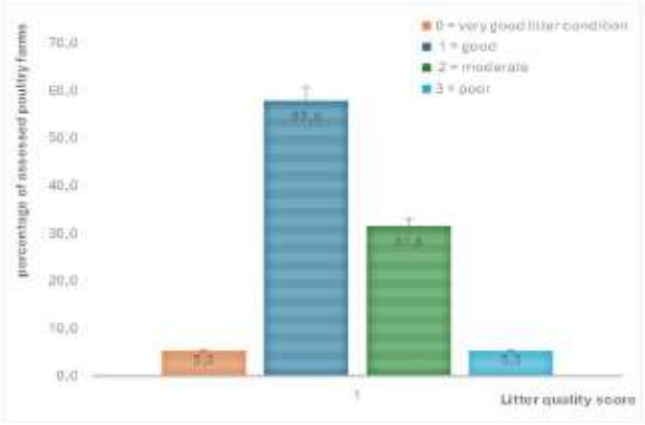

Fig 2: The litter quality score (0–3) across the poultry farms assessed

Each location was given a score based on the condition of the litter, as shown in **Table 1,** by adopting the Welfare Quality® assessment protocol for poultry (2009).

The buildings we visited achieved an average score of 55.52 ± 20.99, indicating acceptable litter quality. The average animal density per drinker was found to be 44.75 ± 21.47. This figure is for all ages combined. This corresponds to the recommendations of the 2009 Welfare Quality® report. This equates to one bell drinker per 100 birds.

Table 1: Ordinal scale level for litter quality

Level of ordinal scale for litter quality	Score
4 (wet and sticky)	0
3	14
2	34
1	67
0 (dry)	100

Human-animal relationship « avoidance distance test »

The avoidance distance test is considered a validated method for assessing human-animal relationships and fear in general in broiler chickens **(Vasdal *et al.,* 2017).** The results presented in **Table 2** indicate that the average number of subjects at arm's length is 7.39, that nearly 50% of them were touched (3.67), and that the touch index is 0.68.

Table 2: Indicators of a good human-animal relationship

	Min	Max	Average	Standard deviation
Number of subjects at arm's length (TT1)	5.25	9.16	7.39	1.19
Number of subjects affected (TT2)	0.83	6.16	3.67	1.47
Touch index = TT1/D	0.08	1.67	0.68	0.43

Feather cleanliness and poultry density

The assessment of plumage cleanliness reflects several aspects of welfare in an integrated manner. However, scores for the cleanliness of breast feathers vary from one farm to another. Nevertheless, plumage is generally clean in all poultry houses, as shown in **Fig. 3** which reveals the total absence of score 3 corresponding to dirty plumage. Score 2, indicating moderately dirty feathers, was recorded on only two farms (No. 4 and No. 8), and score 0, corresponding to clean plumage (during the start-up phase), was recorded on two farms (No. 10 and No. 16).

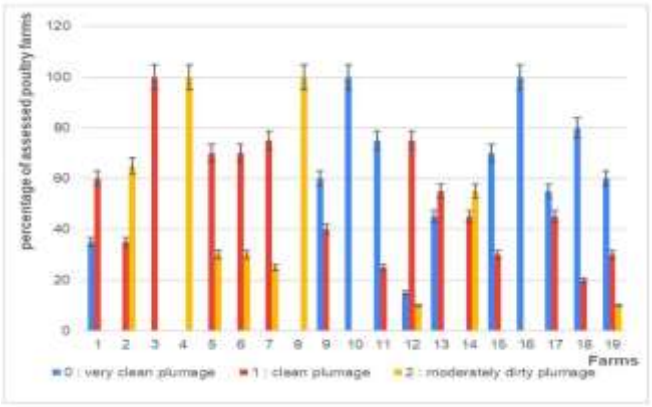

Fig 3. Cleanliness scores of broiler chickens

In general, the subjects in this study were considered clean, with an average cleanliness index of over 99% (**Table 3**). The average stocking density was 13.94 ± 8.75 birds per m², which is perfectly acceptable.

Table 3: Cleanliness index (CI), Density (D) and density index (DI)

	Min	Max	Average	Standard deviation
CI	99.00	99.90	99.51	0.28
D	4.00	34.00	13.94	8.75
DI	25.00	100.00	75.10	21.86

Dust test

The dust level in the buildings visited is 60.15 ± 23.67%, indicating that most of them have a low dust level with a score between 0 (no dust) and 1 (presence of a thin layer of dust).

Thermal Comfort

Temperature and relative humidity influence the thermal comfort of birds (SCAHAW 2000). Huddling indicates that the ambient temperature is too low, while panting and/or holding the wings away from the body indicates that it is too high **(De Jong *et al.*, 2012).** As shown in **Fig. 4,** the number of huddled animals is high. In fact, in at least eleven out of nineteen farms (58%), the score is three out of five per building, indicating that the temperature in these buildings is below ambient standards. Broiler chickens initially respond to heat stress by reducing their activity (walking, standing, preening). Panting was observed in eight of the nineteen farms studied (42%).

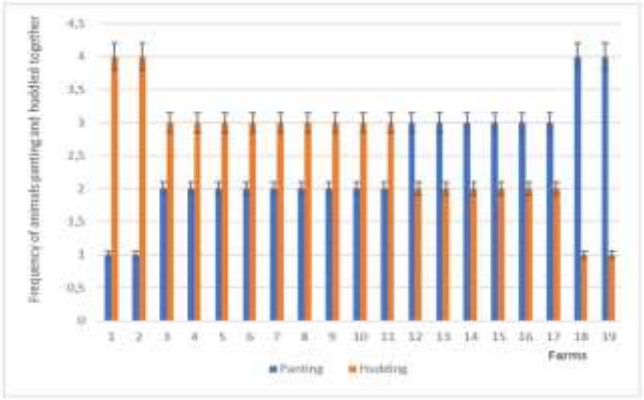

Fig 4. Score for panting and huddling animals

Dermatitis of the paw pads

Figure 5 shows the footpad dermatitis scores. These scores relate to the animals found in the buildings that were visited. In all poultry buildings, 20.1% had lesions with a score of 1 or 2, and no lesions with a score of 3 or 4 were identified.

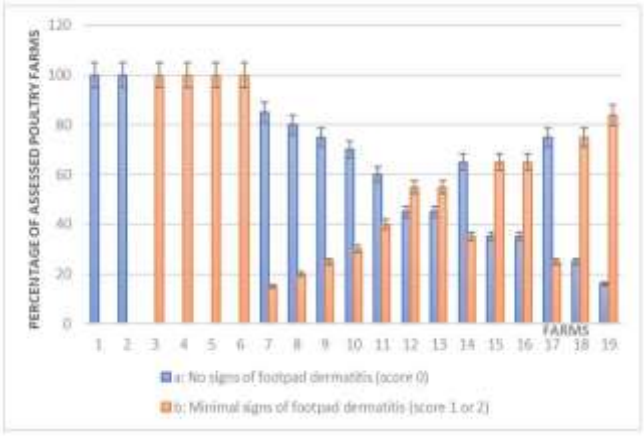

Fig 5. Scores for dermatitis of the footpads (a : score 0 ; b : scores 1 and 2).

Burns on the hocks

Hock burns are contact dermatitis that appear on the back of this joint. Their frequency varies from one building to another **(Fig. 6).**

Animals in poultry houses with a proportion greater than 76% were counted in categories « a » and « b » (scores 0, 1 and 2). The severity of this type of burn depends on the age and quality of the litter. 10.5% of buildings showed no signs of type « a » hock burns and 15.8% showed minimal signs of type « b » burns. Category « c » was not reported.

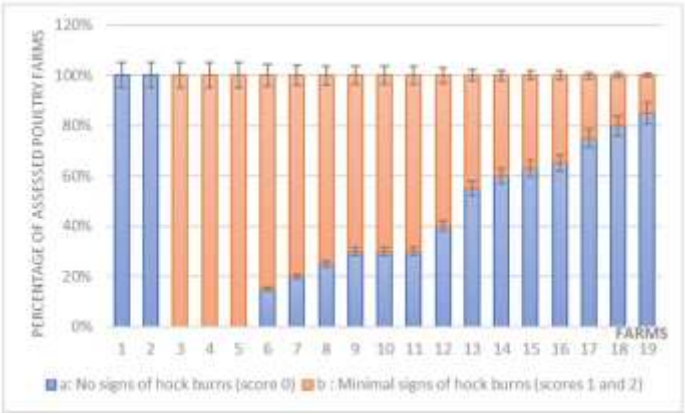

Fig 6: Burn scores on the hock (a: score 0; b: scores 1 and 2)

DISCUSSION

Good-quality litter cushions impact and insulates birds from the floor, keeps them dry and provides comfort **(EFSA 2023).** Clean, dry and crumbly litter is essential for the welfare of poultry, as it allows them to engage in instinctive behaviours such as scratching, foraging and bathing in dust **(Holt *et al.*, 2023).**

The quality of the litter is also affected by ventilation, bird density, diet, and environmental conditions. Consequently, it is an indirect measure of the effectiveness of water pressure (**Moon *et al.*, 2023).** Wet litter under the water source indicates that the drinkers are too low, the pressure is too high, or there is insufficient ballast. If the litter is very dry under the drinkers, the pressure may be too low. According to **Van Emous (2024),** increasing the number of drinkers reduces competition among birds. However, it can also lead to more water being spilled, thereby increasing the moisture content of the litter. Having more drinkers increases the likelihood of spillage, especially if the birds play with the water or if the system is poorly maintained.

Poor litter quality, as indicated by scores of 2 or 3, is widespread, affecting more than a third of poultry buildings visited. It is also linked to significant animal

health and welfare concerns. Poor litter quality is characterized by litter that can be formed into a ball (score of 2) or that sticks to boots and compacts easily (score of 3) **(Brink *et al.,* 2022a ; Brink *et al.,* 2022b ; Schreiter and Freick, 2023)**. Studies confirm that these scores are frequently observed, with up to 36% of buildings receiving a score of 2 or 3. Poor litter quality (scores of 2 or 3) is strongly associated with an increased incidence of footpad dermatitis, hock burns, and skin lesions (**Dinev *et al.,* 2019 ; Brink *et al.,* 2022a; Brink *et al.,* 2022b ; Schreiter and Freick, 2023 ; Kim *et al.,* 2024).** It can also lead to higher emissions of ammonia and microbial loads, impacting both animal and environmental health. Poor litter quality reduces animal welfare, including more frequent plumage damage and behavioral disorders, and increases the risk of disease transmission due to higher moisture and microbial activity.

According to recommendations of the **OIE (2022),** it is essential to use litter correctly to limit adverse effects on the welfare and health of broiler chickens. It must therefore be replaced or treated correctly to prevent the transmission of disease to subsequent animals **(Maurer *et al.,* 2009; Voss-Rech *et al.,* 2017; Delahoy *et al.,* 2018).** According to **Herremans *et al.,* (2021),** litter quality may also influence the occurrence of pododermatitis.

In terms of the relationship between humans and animals, our findings are like those of **Wessel *et al.,* (2022).** They found that between 15% and 47.5% of animals were captured by the touch test. High scores indicate a good relationship between farmers and their animals. According to **Forkman *et al.,* (2007),** a better human-animal relationship results in less fearful animals and more of them being touched by an assessor. The results of the touch test may be affected by lameness or poor leg health, as broilers with mobility issues may not move away quickly enough when startled. This could bias the results. Therefore, the touch test may not accurately reflect the level of fear experienced by lame broilers when approached by humans. This emphasizes the importance of developing alternative methods that are independent of walking ability **(Vasdal *et al.,* 2017).**

During approach tests, lame birds are less likely to move away from humans. This is not necessarily because they are less fearful, but because their physical limitations prevent them from avoiding humans effectively. This reduced ability to escape increases their exposure to negative experiences, which may make them feel more vulnerable **(Silvera *et al.,* 2017).** However, **Bassler *et al.,* (2013)** stated that in indoor farming systems, broiler chickens benefit from a long period of darkness, which allows a greater number of them to be reached. Longer periods of darkness are associated with a decrease in stress and fear of responses towards humans.

Broiler feathers are cleaner in buildings with perfectly dry litter **(Kadi *et al.,* 2015).** In the study by **Boussaada *et al.,* (2022),** the animals showed a continuous decrease in the cleanliness of their plumage from the start to the end of the rearing period. Our results are consistent with those of **Ben Larbi *et al.,* (2024)** who conducted a study in Tunisia and found excellent plumage cleanliness, with a median score of 99%. This observation contradicts previous results suggesting that more than 90% of the birds studied had mild or moderate levels of dirtiness **(Kaukonen *et al.,* 2017 ; Li *et al.,* 2017).** Cleanliness could be considered a potential indicator of broiler chicken welfare, as **Granquist *et al.,* (2019)** found a strong correlation between increased lameness and dirtiness.

According to the **CE (2007),** which published minimum welfare standards for broiler chickens, the maximum stocking density is 33 kg/m². **Butterworth, (2019)** explains that a low stocking density makes grooming and dust bathing easier for broiler chickens, which is essential for maintaining clean plumage. However, **Son, (2013)** stated that stocking density could influence the behaviour and welfare of broiler chickens. Compared to the low-density group, the high-density group showed a more pronounced tendency to adopt resting and standing behaviours. However, our results contradict those of **Hanh *et al.*, (2019)** who found that a high stocking density encouraged Ross 308 chickens to lie on the litter for most of the time.

This resulted in 50% of the chickens having moderately dirty plumage. Large herds and high stocking densities are consistently associated with increased animal welfare problems, including higher mortality rates, more severe foot dermatitis and hock burn, and a reduced ability to express natural behaviours **(Guinebretière *et al.,* 2024 ; Slegers *et al.,* 2024 ; Zhou *et al.,* 2024).** Studies show that small to medium-sized groups (e.g., 3,000–6,000 birds) have better animal welfare than very large farms (e.g., 20,000 birds), including lower malformation rates and higher survival rates **(Sarıca *et al.,* 2021).** High stocking density exacerbates animal welfare problems by increasing competition for resources and restricting movement **(Mocz *et al.,* 2022 ; Guinebretière *et al.,* 2024 ; Slegers *et al.,* 2024).**

Dust plays an important role in the transmission of many infections and can cause direct inflammation of the bronchi, particularly in the presence of ammonia, low humidity and high temperatures **(Kristensen and Wathes 2000 ; Al-Homidan and Robertson 2003).** High dust concentrations, which often exceed the recommended limits, irritate the respiratory system and cause inflammation, as well as increasing susceptibility

to infection in broiler chickens. Chronic dust exposure can result in histological lesions of the respiratory system and reduced growth **(Vučevilo *et al.*, 2018 ; Dominguez *et al.*, 2023).** Environmental factors such as humidity, temperature, and poultry activity (which increases during periods of bright sunlight) directly influence dust levels, consequently affecting poultry welfare **(Ravić *et al.*, 2024).**

Heat stress causes broiler chickens to become less active in terms of walking, standing and preening. This initial adaptive response is intended to minimize internal heat production **(Ahmed *et al.*, 2021 ; Akter *et al.*, 2022 ; Mancinelli *et al.*, 2023).** As temperatures rise above 25–27°C, the birds exhibit more static behaviours, such as lying down or roosting. There is also a significant decrease in feeding and locomotor activities **(Ahmed *et al.*, 2021 ; Branco *et al.*,2021 ; Akter *et al.*, 2022 ; Mancinelli *et al.*,2023 ; Oso *et al.*, 2025).** When temperatures exceed 25°C, panting and wing spreading become prevalent, serving as primary mechanisms for heat dissipation **(Erensoy *et al.*, 2021 ; Mancinelli *et al.*, 2023 ; Onagbesan *et al.*, 2023 ; Oni *et al.*, 2025).** These behaviours are reliable indicators of thermal discomfort and are closely linked to welfare status. This effective physiological mechanism for active heat dissipation is common in broilers, even at stocking densities below 20 kg/m² **(Lolli *et al.*, 2010).** When birds are panting noticeably, ventilation and distribution levels should be adjusted and the ambient temperature lowered. If necessary, stocking density should also be reduced **(SCAHAW, 2000).** Panting increases with the age of the broilers **(Baeza *et al.*, 2012).**

The good scores for plantar dermatitis are probably due to two factors: the good quality of the litter in the buildings visited and the low animal density. **(Kadi *et al.*, (2015)** explain the differences in scores observed in rearing buildings by the condition of the litter on which the chickens live. Access to clean litter helps prevent and remedy contact dermatitis **(Freeman *et al.*, 2020).** According to **Bilgili *et al.*, (2009),** the most obvious cause of footpad dermatitis is related to the litter used, whether in terms of type, quantity or quality. It should also be noted that contact dermatitis can be linked to overcrowding, restricted mobility and weak legs **(SCAHAW 2000).**

Several parameters influence the onset of contact dermatitis. According to **Boussaada and Ouachem (2019)** and **Boussaada *et al.*, (2022),** broiler chickens raised on dry litter have healthier footpads, fewer burns on their hocks, and cleaner plumage. McIlroy et al., (1987) observed the negative effect of density on the frequency of lesions. According to **Dawkins *et al.*, (2004),** the environment (building atmosphere, litter quality) has a greater impact on lesions than density. According **to Kjaer *et al.*, (2006),** the high prevalence of hock burns in heavier poultry could be related to the fact that they spend more time lying on their joints than lighter poultry. According to a study by **Baxter *et al.*, (2018),** poor litter management, combined with high stocking densities, can lead to wet or moldy litter. This situation causes painful hock burns that affect the chickens' ability to move around.

Our results contradict those of **Hanh *et al.*, (2019)** who showed that fast-growing breeds raised indoors exhibited various welfare problems, such as lameness, poor plumage quality, severe hock burns, footpad dermatitis, and fear of human approach.

CONCLUSIONS

Nineteen poultry farms in the province of M'Sila (Algeria) were targeted by a survey questionnaire to assess the welfare of broiler chickens in this region. After processing the results, we concluded that the concept studied was acceptable, particularly after assessing the quality of the litter, the presence of dust and the cleanliness of the feathers, as well as diagnosing contact dermatitis on the hocks and pododermatitis. However, we observed certain behaviours related to rest (panting and grouping) that suggest that a suboptimal environment (uncontrolled ambient temperature, poor ventilation and the presence of gas in the poultry houses) is detrimental to the health of the animals.

Acknowledgment

We would like to thank the broiler breeders in the M'Sila region for their time and cooperation.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Authors' contributions

All authors contributed to the study design and protocol. Material preparation, data collection and analysis were performed by [BAA Abdelhamid]. The first draft of the manuscript was written by [BARA Yamouna], and the lead author, BAA Abdelhamid, read and approved the final manuscript.

REFERENCES

AHMED, E., ABDEL-RAHMAN, M., and GHAREEB, K., 2021. Impacts of Probiotic feeding on Behavior and Welfare related parameters of Heat Stressed Broilers. 4, 87-96. https://doi.org/10.21608/svu.2021.58578.1101

AKTER, S., LIU, Y., CHENG, B., CLASSEN, J., OVIEDO, E., HARRIS, D., and WANG-Li, L., 2022. Impacts of Air Velocity Treatments under Summer Conditions: Part II—Heavy Broiler's Behavioral Response. Animals: an Open Access Journal from MDPI, 12. https://doi.org/10.3390/ani12091050

AL HOMIDAN, A., and ROBERTSON, J.F., 2003. Effect of litter type and stocking density on ammonia, dust concentrations and broiler performance. British Poultry Science, 44, S7-S8.

ARNOULD, C., and LETERRIER, C., 2007. Bien-être animal en élevage de poulets de chair. INRA Prod. Anim., 2007, 20 (1), 41-46.: https://doi.org/10.20870/productions-animales.2007.20.1.3433

BAEZA, E., ARNOULD, C., JLALI, M, CHARTRIN, P., GIGAUD, V., MERCERAND, F., DURAND, C., METEAU, K., LE BIHAN-DUVAL, E., and BERRI, C., 2012. Influence de l'augmentation de l'âge d'abattage des poulets sur la qualité de la viande, le bien-être et les résultats techniques et économiques. Journal of Animal Science, volume 90, numéro 6, juin 2012, pages 2003–2013. DOI : 10.2527/jas.2011-4192

BASSLER, A.W., ARNOULD, C., BUTTERWORTH, A., COLIN, L., DE JONG, I.C., FERRANTE, V., FERRARI, P., HASLAM, S., WEMELSFELDER, F., and BLOKHUIS, H.J., 2013. Potential risk factors associated with contact dermatitis, lameness, negative emotional state, and fear of humans in broiler chicken flocks. Poultry Science, Volume 92, p. 2811–2826. https://doi.org/10.3382/ps.2013-03208

BAXTER, M., BAILIE, C.L., and O'CONNELL, N.E., 2018. An evaluation of potential dustbathing substrates for commercial broiler chickens. Animal, 12, 1933–1941. https://doi.org/10.1017/S1751731117003408

BEN LARBI, M., ASKRI, A., SAIDANI, M., M'HAMDI, N., ZNAÏDI, I.E., BEN BRAIEK, N., and M'HAMDI, H., 2024. On-Farm Assessment of Broiler Welfare in Tunisia Using Welfare Quality® Broiler Protocol. Pakistan J. Zool., vol. 56(6), pp 2613-2619. https://dx.doi.org/10.17582/journal.pjz/20230726143641

BILGILI, S.F., HESS, J.B., BLAKE, J.P., MACKLIN, K.S., SAENMAHAYAK, B., and SIBLEY, J.L., 2009. Influence of bedding material on footpad dermatitis in broiler chickens. Journal of Applied Poultry Research, Volume 18, Issue 3, 583-589. https://doi.org/10.3382/japr.2009-00023

BIRHANU, M., OSEI-AMPONSAH, R., OBESE, F., and DESSIE, T., 2023. Smallholder poultry production in the context of increasing global food prices: roles in poverty reduction and food security. Animal Frontiers: The Review Magazine of Animal Agriculture, 13, 17 - 25. https://doi.org/10.1093/af/vfac069

BOUSSAADA, T., and OUACHEM, D., 2019. Alternative bedding materials to improve growth performance and welfare of broilers. Int. J. Poult. Sci., 18(9): 431–437.

BOUSSAADA, T., LAKHDARI, K., BENATALLAH, S.A., and MERADI, S., 2022. Effets des types de litière courants et de leurs propriétés physicochimiques sur le bien-être des poulets de chair. Veterinary World, 15(6): 1523-1529. https://doi.org/10.14202/vetworld.2022.1523-1529

BRANCO, T., MOURA, D., De ALENCAR NÄÄS, I., DA SILVA LIMA, N., KLEIN, D., and OLIVEIRA, S., 2021. The Sequential Behavior Pattern Analysis of Broiler Chickens Exposed to Heat Stress. Agri Engineering. https://doi.org/10.3390/agriengineering3030030

BRINK, M., JANSSENS, G., and DELEZIE, E., 2022a. How do moisture content, friability, and crust development of litter influence ammonia concentrations in broiler production? Livestock Science. https://doi.org/10.1016/j.livsci.2022.105109

BRINK, M., JANSSENS, G., DEMEYER, P., BAĞCI, Ö., and DELEZIE, E., 2022b. Ammonia concentrations, litter quality, performance and some welfare parameters of broilers kept on different bedding materials. British Poultry Science, 63, 768 - 778. https://doi.org/10.1080/00071668.2022.2106775

BUTTERWORTH, A. 2019. Effets d'une densité de peuplement élevée sur les poulets de chair et les dindes. CAB Rev. Perspect. Agric. Veter. Sci. Nutr. Nat. Res, 14.

DAWKINS, M.S., DONNELY, C.A., and JONES, T.A., 2004. Chicken welfare is influenced more by housing conditions than by stocking density. Nature, 427: 342 – 344. DOI: 10.1038/nature02226

DE JONG, I., BERG, C., BUTTERWORTH, A., and ESTEVÉZ, I., 2012. Scientific report updating the EFSA opinions on the welfare of broilers and broiler breeders. Supporting Publications 2012: EN-295. https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/sp.efsa.2012.EN-295

DELAHOY, M., WODNIK, B., MCALILEY, L., PENAKALAPATI, G., SWARTHOUT, J., FREEMAN, M., and LEVY, K., 2018. Pathogens transmitted in animal feces in low- and middle-income countries. International Journal of Hygiene and Environmental Health, 221, 661 - 676. https://doi.org/10.1016/j.ijheh.2018.03.005

DINEV, I., DENEV, S., VASHIN, I., KANAKOV, D., and RUSENOVA, N., 2019. Pathomorphological investigations on the prevalence of contact dermatitis lesions in broiler chickens. J. Appl. Anim. Res., 47(1): 129–134. https://doi.org/10.1080/09712119.2019.1584105

DOMINGUEZ, D., HOFSTETTER, D., BUIATTE, V., PARET, M., DUNN, P., and LORENZONI, A., 2023. Effect of Hardwood Dust and Ammonia Gas on the Respiratory Integrity of Broiler Chickens. Avian diseases, 67 3, 237-244. https://doi.org/10.1637/aviandiseases-d-22-00080

DSA, 2023. « Direction des Services Agricoles de M'Sila ». Bilan de la production agricole de la wilaya de M'Sila.

EFSA, 2023. "European Food Safety Authority". Scientific Opinion on the Welfare of Broilers on Farm. The EFSA Journal 21 (2): 236. https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.7788

ERENSOY, K., SARICA, M., NOUBANDIGUIM, M., and ASLAN, R., 2021. The effects of intermittent feeding and cold water on welfare status and meat quality in broiler chickens reared under daily heat stress. Tropical Animal Health and Production, 53. https://doi.org/10.1007/s11250-021-02998-4

FAO, 2025. "Food and Agriculture Organization of the United Nations". FAOSTAT https://www.fao.org/faostat/fr/#data/QCL

FERRAH, A., IKHLEF, H., and BENIDIR, M., 2024. Structuring and Development of Poultry Sectors in Algeria: Limits of Modernization Policies: The Case of the "Turkey" Sector (2000-2020). Agricultural Science

Digest - 44(6): 1147-1153. https://doi.org/10.18805/ag.df-584

FORKMAN, B., BOISSY, A., MEUNIER-SALAÜN, M.C., CANALI, E., and JONES, R.B., 2007. A critical review of fear tests used on cattle, pigs, sheep, poultry and horses. Physiology and Behavior 92, 340–374. doi: 10.1016/j.physbeh.2007.03.016

FREEMAN, N., TUYTTENS, F.A.M., JOHNSON, A., MARSHALL, V., GARMYN, A., and JACOBS, L., 2020. Remedying Contact Dermatitis in Broiler Chickens with Novel Flooring Treatments. 10 (10):1761. Animals. doi: 10.3390/ani10101761

GARRETA, A., and ORAIN, M.N., 2019. Les enjeux relatifs aux conditions d'élevage, de transport et d'abattage en matière de bien-être animal. Avis du Conseil économique, social et environnemental. 114p. https://www.lecese.fr/sites/default/files/pdf/Avis/2019/2019_29_bienetre_animal.pdf

GRANQUIST, E.G., VASDAL, G., DE JONG, I.C., and MOE, R.O., 2019. Lameness and its relationship with health and production measures in broiler chickens. Animal, 13(10): 2365-2372. Doi :10.1017/S1751731119000466

GUINEBRETIÈRE, M., WARIN, L., MOYSAN, J., MÉDA, B., MOCZ, F., BIHAN-DUVAL, E., THOMAS, R., KEITA, A., and MIGNON-GRASTEAU, S., 2024. Effects of strain and stocking density on leg health, activity, and use of enrichments in conventional broiler chicken production. Poultry Science, 103. https://doi.org/10.1016/j.psj.2024.103993

HAN QUANG HANH, NGUYEN, THI XUAN and VU DINH, TON, 2019. Integration of animal welfare into assessment of broiler chicken production systems toward sustainable development in Vietnam. Livestock Research for Rural Development 31 (5) 2019. http://www.lrrd.org/lrrd31/5/hqhan31066.html

HERREMANS, S., LEFEVRE, A., PAPES, M., DECRUYENAERE, V., BURNY, P.H., FROIDMONT, E., and WAVREILLE, J., 2021. Analyse du principe de dérogation des densités d'élevage en poulets de chair standard : incidences sur le bien-être animal et la rentabilité. RAPPORT FINAL DE SYNTHESE. Le centre wallon de recherches agronomiques. 105p.

HOLT, R.V., VAS, J., VASDAL, G., and NEWBERRY, R.C., 2023. A Buffet of Litters–Broiler Chickens Behave Differently According to Litter Type and Freshness. Applied Animal Behaviour Science 260 (105856). https://doi.org/10.1016/j.applanim.2023.105856

KADI, S.A., BOUCHEMA, A., and MOUHOUS A., 2015. Évaluation du bien être des poulets de chair en élevage industriel en Algérie. Onzièmes Journées de la Recherche Avicole et Palmipèdes à Foie Gras, Tours, les 25 et 26 mars 2015.

KAUKONEN, E., NORRING, M., and VALROS, A., 2017. Evaluating the effects of bedding materials and elevated platforms on contact dermatitis and plumage cleanliness of commercial broilers and litter condition in broiler houses. Br. Poult. Sci., 58: 480–489. https://doi.org/10.1080/00071668.2017.1340588

KIM, C., KIM, K., CHUN, J., Lim, S., and JEON, J., 2024. Animal welfare indicators and stress response of broiler chickens raised at low and high stocking density. Journal of Animal Science and Technology. https://doi.org/10.5187/jast.2024.e64

KJAER, J.B., SU, G., NIELSEN, B.L., and SORENSEN, P., 2006. Foot pad dermatitis and hock burn in broiler chickens and degree of inheritance, Poultry Sci., 85, 1342–1348. https://doi.org/10.1093/ps/85.8.1342

KRISTENSEN, H.H., and WATHES, C.M., 2000. Ammonia and poultry welfare : a review. World Poultry Sci. J.56:235-245. https://doi.org/10.1079/WPS20000018

LI, H, WEN, X., ALPHIN, R., ZHU, Z., and ZHOU, Z., 2017. Effects of two different broiler flooring systems on production performance welfare and the environment under commercial production conditions. Poult. Sci. J., 96: 1108–1119. https://doi.org/10.3382/ps/pew440

LOLLI, S., BESSEI, W., CAHANER, A., YADGARI, L., and FERRANTE, V., 2010. The influence of stocking density on the behaviour of featherless and normally feathered broilers under hot ambient temperature. Archiv Fur Geflugelkunde, 74, 73-80.

MANCINELLI, C., BALDI, G., SOGLIA, F., MATTIOLI, S., SIRRI, F., PETRACCI, M., CASTELLINI, C., and ZAMPIGA, M., 2023. Impact of chronic heat stress on behavior, oxidative status and meat quality traits of fast-growing broiler chickens. Frontiers in Physiology, 14. https://doi.org/10.3389/fphys.2023.1242094

MAURER, V., AMSLER, Z., PERLER, E., and HECKENDORN, F., 2009. Poultry litter as a source of gastrointestinal helminth infections. Veterinary parasitology, 161 3-4, 255-60. https://doi.org/10.1016/j.vetpar.2009.01.020

MCILROY, S.G., GOODALL, E.A., and MCMURRAY, C.H., 1987. A contact dermatitis of broilers – epidemiological findings. Avian Pathology, 16: 93 – 105. https://doi.org/10.1080/03079458708436355

MOCZ, F., MICHEL, V., JANVROT, M., MOYSAN, J., KEITA, A., RIBER, A., and GUINEBRETIERE, M., 2022. Positive Effects of Elevated Platforms and Straw Bales on the Welfare of Fast-Growing Broiler Chickens Reared at Two Different Stocking Densities. Animals: an Open Access Journal from MDPI, 12. https://doi.org/10.3390/ani12050542

MOON, J., DUBIEN, J., RAMACHANDRAN, R., LIANG, Y., DRIDI, S., and TABLER, T., 2023. Effects of a Sprinkler and Cool Cell Combined System on Cooling Water Usage, Litter Moisture, and Indoor Environment of Broiler Houses. Animals: An Open Access Journal from MDPI, 13. https://doi.org/10.3390/ani13182939

OCDE/FAO, 2024. Perspectives agricoles de l'OCDE et de la FAO 2024-2033. OCDE-FAO. Paris et Rome. https://doi.org/10.1787/96f19970-fr

OIE., 2022. " Office International des Épizooties ». Code sanitaire pour les animaux terrestres. Chapitre 7.10 - Bien-être animal dans les systèmes de production de poulets de chair.

ONAGBESAN, O., UYANGA, V., OSO, O, TONA, K., and OKE, O., 2023. Alleviating heat stress effects in poultry: updates on methods and mechanisms of actions. Frontiers in Veterinary Science, 10. https://doi.org/10.3389/fvets.2023.1255520

ONI, A., BELLO, Y., IBIGBAMI, D., ISHOLA, C., ADESANYA, S., ADENIRAN, D., and OKE, O., 2025. Effects of early-age feed restriction and thermal conditioning on the physiological and performance responses of broiler chickens under heat stress. Scientific Reports, 15. https://doi.org/10.1038/s41598-025-01048-5

OSO, O., MEJIA-ABAUNZA, N., BODEMPUDI, V., CHEN, X, CHEN, C., AGGREY, S., and LI, G., 2025. Automatic analysis of high, medium, and low activities of broilers with heat stress operations via image processing and machine learning. Poultry Science, 104. https://doi.org/10.1016/j.psj.2025.104954

RAVIC, I., OSTOVIC, M., KABALIN, A., KOVACIC, M., MATKOVIC, K., GOTTSTEIN, Ž., and TOMIC, H., 2024. Dust and Bacterial Air Contamination in a Broiler House in Summer and Winter. Agriculture. https://doi.org/10.3390/agriculture14050778

SARICA, M., KARAKOÇ, K., and ERENSOY, K., 2021. Effects of varying group sizes on performance, body defects, and productivity in broiler chickens. Archives Animal Breeding, 65, 171 - 181. https://doi.org/10.5194/aab-65-171-2022

SCAHAW., 2000. « Scientific Committee on Animal Health and Animal Welfare » : The Welfare of Chickens Kept for Meat Production (Broilers). 150p. https://food.ec.europa.eu/system/files/2020-12/sci-com_scah_out39_en.pdf

SCHREITER, R., and FREICK, M., 2023. Flock-level risk factors of litter condition for the occurrence of plumage damage and skin lesions in commercial laying hen farms. Poultry Science, 102. https://doi.org/10.1016/j.psj.2023.102705

SILVERA, A., KNOWLES, T., BUTTERWORTH, A., BERCKMANS, D., VRANKEN, E., and BLOKHUIS, H., 2017. Lameness assessment with automatic monitoring of activity in commercial broiler flocks. Poultry science, 96 7, 2013-2017. https://doi.org/10.3382/ps/pex023.

SINGH, M., MOLLIER, R., PATON, R., PONGENER, N., YADAV, R., SINGH, V., KATIYAR, R., KUMAR, R., SONIA, C., BHATT, M., BABU, S., RAJKHOWA, D., and MISHRA, V., 2022. Backyard poultry farming with improved germplasm: Sustainable food production and nutritional security in fragile ecosystem. 6. https://doi.org/10.3389/fsufs.2022.962268

SLEGERS, Y., HOSTENS, M., MATTHIJS, M., STEGEMAN, J., and DE WIT, J., 2024. Broiler flocks in production systems with slower-growing breeds and reduced stocking density receive fewer antibiotic treatments and have lower mortality. Poultry Science, 103. https://doi.org/10.1016/j.psj.2024.104197

SON, J.H. 2013. The Effect of Stocking Density on the Behaviour and Welfare Indexes of Broiler Chickens. Journal of Agricultural Science and Technology A 3 (2013) 307-311.

VAN EMOUS, R. 2024. Effects of water access time and unlimited access to alfalfa straw on litter quality, performance, and behavior of breeder pullets. Poultry science, 103 6, 103773. https://doi.org/10.1016/j.psj.2024.103773

VASDAL, G., MOE, R., DE JONG, I., and GRANQUIST, E., 2017. The relationship between measures of fear of humans and lameness in broiler chicken flocks. Animal: an international journal of animal bioscience, 12 2, 334-339. https://doi.org/10.1017/s1751731117001434

VOSS-RECH, D., TREVISOL, I., BRENTANO, L., SILVA, V., REBELATTO, R., JAENISCH, F., OKINO, C., MORES, M., COLDEBELLA, A., BOTTON, S., and VAZ, C., 2017. Impact of treatments for recycled broiler litter on the viability and infectivity of microorganisms. Veterinary microbiology, 203, 308-314. https://doi.org/10.1016/j.vetmic.2017.03.020

VUČEMILO, M., MATKOVIĆ, K., VINKOVIĆ, B., MACAN, J., VARNAI, V., PRESTER, L., GRANIĆ, K., and ORCT, T., 2018. Effect of microclimate on the airborne dust and endotoxin concentration in a broiler house. Czech Journal of Animal Science, 53, 83-89. https://doi.org/10.17221/329-cjas

WELFARE QUALITY®. 2009. Welfare Quality® assessment protocol for poultry (broilers, laying hens). Welfare Quality® Consortium, Lelystad, the Netherlands, 111p.

WESSEL, J., RAUCH, E., HARTMANNSGRUBER, S., ERHARD, M., SCHMIDT, P., SCHADE, B., and LOUTON, H., 2022. A comparison of two manual catching methods of broiler considering injuries and behavior. Poultry Science 101:102127. https://doi.org/10.1016/j.psj.2022.102127

ZHOU, S., WATCHARAANANTAPONG, P., YANG, X., THORNTON, T., GAN, H., TABLER, T., PRADO, M., and ZHAO, Y., 2024. Evaluating broiler welfare and behavior as affected by growth rate and stocking density. Poultry Science, 103. https://doi.org/10.1016/j.psj.2024.103459

How to cite this article:

BAA Abdelhamid* and BARA Yamouna, 2026. Application of the Welfare Quality® Protocol in Semi-arid Broiler Production Systems. Journal of Applied Veterinary Sciences, 11 (1): 76-85. https://doi.org/10.21608/javs.2025.436536.1809