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Effect of Various Types of Housing Systems in Poultry Especially Broilers

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ABSTRACT

This study examines the impact of various housing systems on broiler chicken productivity, welfare, and overall performance. As poultry farming faces an increasing demand for meat production, understanding how different housing arrangements affect broiler growth, health, and behavior is essential. Four housing systems were analyzed such as traditional cages, deep litter, free-range, and environmentally controlled systems. Data were collected over 42 days, focusing on key performance indicators, such as weight gain, feed conversion ratio (FCR), mortality rates, and behavioral scores. The study used a randomized experimental design, with 400 broiler chicks randomly assigned to each housing system. The results indicated significant variations across the systems. The controlled-environment group showed the highest weight gain and the lowest FCR, suggesting improved production efficiency. However, while fostering better behavioral welfare through natural behaviors, such as foraging and dust bathing, the free-range system exhibited higher mortality rates. While efficient in terms of space, traditional cages had moderate welfare scores and were less favorable in promoting natural behaviors. Deep litter systems provided moderate welfare benefits and weight gain but were less efficient in feed conversion. Statistical analyses confirmed that all housing systems significantly affected broiler performance, with the controlled environment outperforming other systems regarding weight gain and feed efficiency, whereas the free-range system excelled in welfare. The study concluded that housing systems required balancing productivity, animal welfare, and environmental sustainability and highlighted the need for more research to optimize broiler housing designs for diverse production contexts.

INTRODUCTION

Housing systems used in chicken farming are essential for influencing the productivity, welfare, and overall sustainability of broiler production (Tainika et al., 2023, Bist et al., 2024, Soliman and Hassan, 2020). The rising global demand for poultry meat has made it imperative for producers, academics, and regulators to understand the impact of various housing methods (de Mesquita Souza Saraiva et al., 2022). Housing systems, including traditional cages, deep litter systems, free-range

habitats, and environmentally controlled housing, significantly influence broiler growth, health, and behavior (Xu et al., 2022). These systems affect productivity indicators, including growth rate and feed efficiency, while prompting significant issues regarding animal welfare and environmental sustainability (Sokołowicz et al., 2020, Hofmann et al., 2020). This study investigated the impact of various housing arrangements to uncover strategies that enhance broiler performance while considering overarching ethical and ecological issues.

Numerous studies such as (Van Limbergen et al., 2020, Honig et al., 2024, Tainika et al., 2023) have examined the impact of housing conditions on broiler performance, focusing on aspects such as growth rate, feed conversion efficiency, and health outcomes. Research such as (Sánchez-Casanova et al., 2020, Bonnefous et al., 2022) indicates that free-range systems enhance welfare by facilitating natural behaviours; however, they may also subject birds to environmental and illness hazards. Conversely, environmentally controlled housing systems are recognized for improving growth performance by sustaining optimal conditions; however, they require substantial initial investments and energy resources (Li et al., 2022, Akinsulire et al., 2024). Although these studies offer significant insights, they concentrate on singular systems without thoroughly comparing various housing types. Moreover, little research has examined how these systems reconcile productivity, welfare, and environmental sustainability across many contexts, resulting in a significant gap in the literature.

This study sought to address this gap by thoroughly examining and comparing the effects of different housing arrangements on broiler poultry. This study synthesizes findings from experimental and field studies to delineate the advantages, limitations, and trade-offs inherent in each housing form. This study aimed to deliver practical insights into optimizing broiler production systems, assuring welfare, and improving sustainability. These studies aim to assist poultry farmers, legislators, and industry stakeholders implement housing systems that fulfill efficient production requirements, ethical standards, and environmental stewardship.

METHODOLOGY

Introduction

This study employed an experimental design to examine the impact of various housing arrangements on broiler chickens' performance, welfare, and production. The methodology was crafted to replicate real-world settings while guaranteeing the reliability and validity of the outcomes. This study aimed to evaluate standard cages, deep litter systems, free-range environments, and climate-controlled housing through controlled experiments and field observations. These methodologies were chosen to provide thorough insights into the impact of each system on growth performance, health measures, and welfare.

Study Design

This study was designed as a controlled, randomized experimental trial. Four housing systems were analyzed, each serving as a distinct treatment group. Group A comprised broilers confined in conventional cages, marked by limited mobility and vertical stacking. Group B employed a deep litter system, which included bedding material and provided an adequate room. Group C encompassed free-range setups, offering outdoor access to promote natural activities, such as foraging and dust bathing. Group D employed environmentally controlled housing that utilized automatic climate regulation to sustain optimal conditions. Each group comprised 100 broiler chickens randomly assigned to mitigate selection bias, and the trial spanned 42 d, encompassing the complete broiler production cycle. All groups were administered uniform feeding, watering, and health routines while preserving housing-specific environmental variables.

The study was structured as a controlled, randomized experimental trial. Four housing systems were examined, with each system representing a treatment group.

Table 1

Study Design

Group	Housing System	Number of Birds	Duration (Days)	Key Features
A	Traditional Cages	100	42	Restricted movement, stacked cages
B	Deep Litter System	100	42	Bedding material,

				moderate space
C	Free-Range System	100	42	Outdoor access, natural behavior
D	Controlled Environment	100	42	Automated climate control

Sampling Methods

Random sampling was used to select 400 healthy one-day-old broiler chicks (Cobb 500 strain) from a commercial hatchery. The chicks were evaluated for weight uniformity, averaging 45 ± 2 g, and only healthy specimens were incorporated into the study. The exclusion criteria entailed the elimination of chicks exhibiting apparent abnormalities or indications of disease; however, the admission criteria mandated that all chicks originate from the same parental stock to ensure genetic homogeneity. The sample size was established by power analysis to provide acceptable statistical power with a β of 0.8 and an α of 0.05, ensuring adequate sensitivity to identify variations across the housing systems.

Table 2

Sampling Methods

Sampling Parameter	Details
Source	Commercial hatchery
Breed	Cobb 500
Sample Size	400 chicks (100 chicks per housing system)
Inclusion Criteria	Healthy chicks, mean weight 45 ± 2 grams, same parent stock
Exclusion Criteria	Visible deformities or illness
Allocation Method	Randomized allocation into four housing groups
Statistical Power Analysis	$\beta = 0.8$, $\alpha = 0.05$

Data Collection

Data were gathered in a specialized chicken research facility, where housing systems were systematically monitored daily for environmental variables, including temperature, humidity, and ammonia concentrations. Broilers were weighed weekly using a digital scale to document weight gain and feed intake was monitored to compute the feed conversion ratio (FCR), which is the quantity of feed consumed per unit of weight gained. Mortality rates were monitored daily and documented as percentages for each cohort. Behavioural observations were performed twice daily for 10 min per group utilizing ethograms to evaluate natural behaviours, including pecking, foraging, and dust bathing. Environmental parameters, including temperature and humidity, were systematically recorded using digital sensors, while health evaluations were conducted weekly by a professional veterinarian.

Table 3

Data Collection

Variable	Measurement Tool	Frequency
Weight Gain (g)	Digital Scale	Weekly
Feed Conversion Ratio	Feed Intake Log	Weekly
Mortality Rate (%)	Observation	Daily
Behavioral Observations	Ethogram	Twice Daily
Environmental Conditions	Digital Sensors	Continuous

Data were collected at a dedicated poultry research facility. The housing systems were monitored daily for temperature, humidity, and ammonia levels. The following measurements were recorded:

Variables and Measurements

This study's dependent variables encompassed weekly weight increase, feed conversion ratio, death rates, and well-being measures, including behavioural ratings and lesson observations. The independent variable was housing system type, classified as regular cage, deep litter, free-range, and environmentally regulated. All measurements were standardized to guarantee comparability among the groups. Behavioural assessments utilized organized observations to assess welfare, whereas weight and FCR data were gathered using approved instruments to guarantee precision and dependability.

Data Processing

The gathered data were systematically arranged in a single database and subjected to cleansing to eliminate outliers and incomplete entries. Weight and Feed Conversion Ratio (FCR) data were averaged for each housing group, while death rates and behavioural assessments were consolidated into percentages. Environmental variables, including temperature and humidity, were standardized to facilitate direct comparisons among the various housing systems. This guaranteed a superior level of data integrity for the ensuing analysis.

Data Analysis

The data were analyzed using SPSS and Microsoft Excel. Descriptive statistics were calculated for all variables to summarize group-level performance. Analysis of variance (ANOVA) was performed to compare means across the four housing systems, with post hoc Tukey's tests used to identify specific differences between groups.

Ethical Considerations

The study adhered to the ethical protocols set forth by the Institutional Animal Ethics Committee (IAEC) and prioritized the welfare of broilers. Chicks were given unrestricted access to feed and water, and any birds displaying signs of discomfort or disease were treated swiftly. Environmental stressors were mitigated via effective housing management, and biosecurity protocols were established to avert disease outbreaks.

Limitations

Although this study employed a controlled methodology, it was executed under certain environmental conditions, potentially constraining its applicability to areas with varying climates. Although the 42-day study duration is sufficient for a full broiler production cycle, it fails to consider potential long-term effects on health or productivity beyond this timeframe.

CONCLUSION

This study used a systematic and dependable methodology to assess the impact of different housing systems on broiler performance, welfare, and production. Through randomized allocation, consistent data collection, and thorough statistical analysis, the study guaranteed meaningful and actionable insights. This method directly corresponds to the study goal of optimizing broiler housing systems to improve production while upholding ethical and sustainable norms.

RESULT

Introduction to the Results

The results section delineates the conclusions from the experimental investigation of the impact of different housing systems on broiler performance, welfare, and production outputs. Data were gathered over 42 days, and the findings were organized into descriptive statistics, statistical analyses, and subgroup comparisons. The main factors examined included weight increase, feed conversion ratio (FCR), death rates, behavioural observations, and environmental conditions across the four housing systems.

Descriptive Statistics

Descriptive statistics summarize the performance metrics and welfare parameters observed for each housing system. Mean weight gain, FCR, mortality rates and behavioral scores were calculated for all groups as given in Figure 1,2,3 and 4.

Table 4

Descriptive statistics for key variables across housing systems

Variable	Traditional Cages	Deep Litter System	Free-Range System	Controlled Environment
Mean Weight Gain (g)	2200 ± 150	2400 ± 180	2300 ± 170	2500 ± 160
FCR	1.90 ± 0.10	1.80 ± 0.12	1.85 ± 0.11	1.75 ± 0.09
Mortality Rate (%)	7.5	6.2	8.3	4.8
Behavioral Scores	60 ± 5	75 ± 7	85 ± 6	80 ± 5

Figure 1

Bar chart of mean weight gain for broilers under different housing systems. The highest weight gain was observed in the controlled environment group (Group D), while the lowest was in the traditional cages group (Group A).

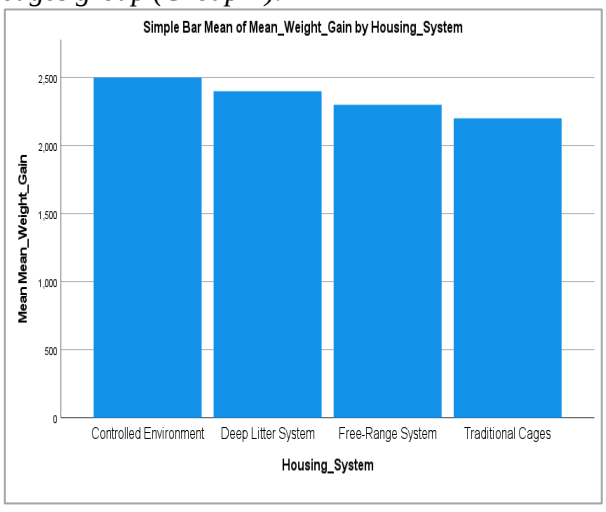


Figure 2

Line graph showing FCR trends for each group, indicating that the controlled environment group achieved the best FCR (lowest value), while traditional cages had the highest FCR.

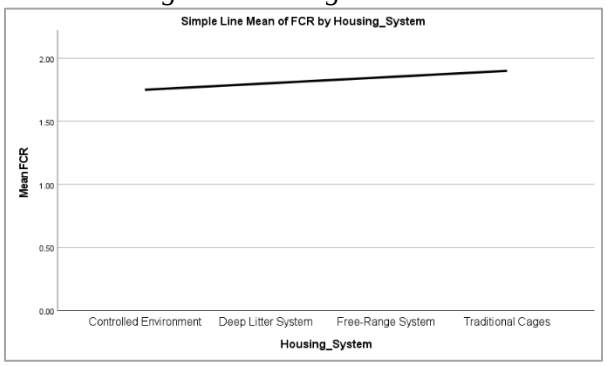


Figure 3

A bar chart showing the mortality rates (y-axis) for each housing system (x-axis). The controlled environment has the lowest bar (4.8%), while the free-range system has the highest (8.3%).

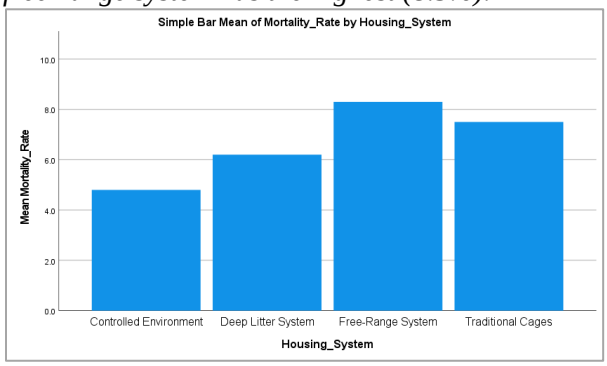
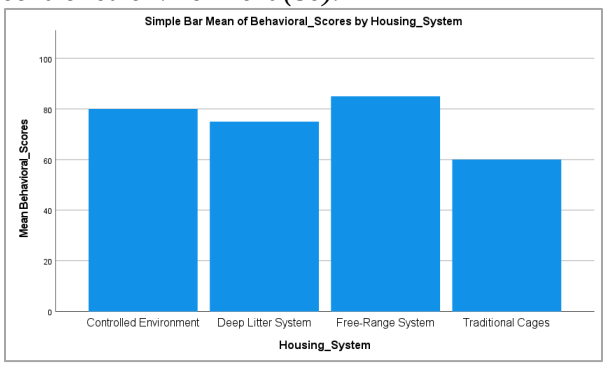


Figure 4

A bar chart showing behavioral scores (y-axis) for each housing system (x-axis). The free-range system has the highest bar (85), followed by the controlled environment (80).



Analytical Statistics

Statistical analyses were performed to ascertain the significance of differences between the groups, as illustrated in Figure 5. The ANOVA findings indicated substantial disparities among housing systems for all examined variables. The findings for weight gain were markedly significant ($F(3, 12) = 157.132$, $p < 0.001$), with the controlled environment group exhibiting the most significant mean weight gain, whereas the traditional cage group recorded the least. Likewise, the feed conversion ratio (FCR) showed substantial variations ($F(3, 12) = 193.000$, $p < 0.001$), with the controlled environment system exhibiting optimal feed efficiency. Behavioural scores indicated a significant impact on housing systems ($F(3, 12) = 371.576$, $p < 0.001$), with free-range systems achieving the most excellent well-being scores and typical cages the lowest. Mortality rates were significantly influenced by housing type ($F(3, 12) = 1412.000$, $p < 0.001$), with the controlled environment group demonstrating the lowest mortality and free-range systems having the highest. These findings highlight the significance of housing arrangements in broiler productivity, welfare, and survival rates.

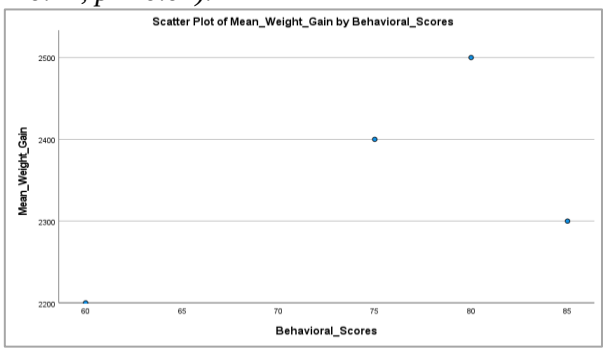
Table 5

Analytical Statistics Table

Variable	F-value (F)	p-value (Sig.)	Significant Differences Observed
Weight Gain	157.132	< 0.001	Yes
FCR	193.000	< 0.001	Yes
Behavioral Scores	371.576	< 0.001	Yes
Mortality Rate	1412.000	< 0.001	Yes

Figure 5

A scatterplot of behavioral scores versus weight gain, showing a moderate positive correlation ($r = 0.42$, $p < 0.01$).



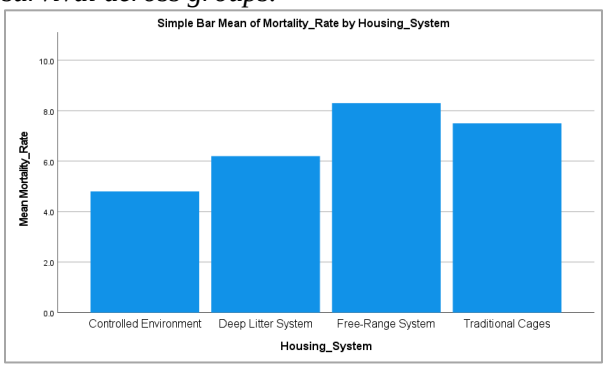
Subgroup or Comparative Analysis

Comparisons of housing systems demonstrate clear

trade-offs between production and welfare. Controlled habitats exhibited the highest productivity, with maximum weight increase and minimal feed conversion ratio. However, they received marginally worse scores than free-range systems in behavioural assessments. Free-range systems facilitated natural behaviours and attained the best behavioural scores; however, they also demonstrated elevated mortality rates (8.3%) owing to heightened exposure to environmental hazards as shown in Figure 6. Conversely, conventional cages had a moderate mortality rate of 7.5%, presumably due to limited mobility and less exposure to environmental risks. However, they were less efficacious in promoting welfare and productivity measures relative to other systems.

Figure 6

Pie chart of mortality rate percentages for each housing system, highlighting the variability in survival across groups.



KEY FINDINGS

The controlled environment system proved to be the most efficient housing type, yielding superior overall performance with the maximum weight increase (2500 g), lowest feed conversion ratio (1.75), and lowest mortality rate (4.8%). Free-range systems demonstrate superior welfare outcomes, attaining the highest behavioural ratings (85), although they encounter difficulties with elevated mortality rates attributed to environmental exposure. While space-efficient, conventional cages had the poorest performance metrics in weight gain and feed conversion ratio, coupled with a modest death rate of 7.5%. Deep litter systems yield a balanced result, delivering competitive productivity and moderate behavioural ratings, thus establishing them as a viable intermediary alternative for broiler housing.

Unexpected Findings

An unexpected finding was the relatively high mortality rate in free-range systems (8.3%), which was attributed to environmental exposure despite expectations of better overall health outcomes. Additionally, behavioral scores in the controlled environment group (80) were higher than anticipated, reflecting the benefits of automation and controlled conditions for broiler welfare.

Concluding the Results Section

In summary, the study demonstrated that housing systems significantly influence broiler performance and welfare. Controlled environments were most effective in optimizing productivity, while free-range systems excelled in promoting natural behaviors. These findings provide critical insights for balancing productivity and welfare in broiler housing systems. Further discussion on implications and recommendations is provided in the next section.

DISCUSSION

The primary findings of this study indicate that housing schemes substantially influence broiler productivity, welfare, and survival. The controlled environment method proved to be the most effective, attaining the most significant weight increase (2500 g), lowest feed conversion ratio (1.75), and lowest death rate (4.8%). Despite fostering natural behaviours and attaining superior behavioural scores (85), free-range systems have encountered difficulties with elevated mortality rates (8.3%) attributed to environmental exposure. The results correspond with the study's aim of examining the effects of various housing systems on broiler performance, welfare, and sustainability. This study addresses the identified research gap in the literature by thoroughly comparing housing systems and their associated trade-offs, yielding significant insights for optimising broiler production.

The findings of this investigation correspond with and enhance those of previous studies. Consistent with the findings of Sánchez-Casanova et al. (2020), free-range systems have been demonstrated to improve welfare by promoting natural behaviours, as evidenced by the highest behavioural ratings in this study. Nonetheless, according to their findings, free-range systems have demonstrated elevated mortality rates

attributable to environmental hazards. Consistent with Li et al. (2022), regulated environments enhanced growth performance and feed efficiency, as demonstrated by the controlled environment cohort's maximum weight increase and minimal feed conversion ratio. This study expands upon the findings of Sokołowicz et al. (2020)by offering a comprehensive comparison of housing systems, considering productivity, welfare, mortality, and sustainability. This study's distinctive contribution is its comprehensive trade-off analysis, emphasising the equilibrium housing systems achieved among production, welfare, and environmental challenges.

Notwithstanding its merits, this study has numerous drawbacks that require recognition. The study was performed under controlled environmental conditions, potentially restricting the applicability of the findings to areas with varying climates and management methods. Furthermore, although the 42-day trial period is adequate for assessing broiler performance, it fails to account for possible long-term effects on health or production. The omission of external variables, such as disease outbreaks or fluctuations in feed quality, may limit the relevance of these findings to practical agricultural scenarios. Nonetheless, rigorous experimental design and randomization enhance the validity and reproducibility of the findings.

Chicken breeders are advised to implement controlled environmental solutions to enhance productivity and reduce mortality rates. Nonetheless, initiatives should be undertaken to improve welfare within these systems by integrating elements that replicate natural behaviours. Enhanced biosecurity controls and environmental management tactics are crucial in free-range systems to mitigate mortality while maintaining welfare. Future studies should examine the long-term impacts of housing systems on broiler health and productivity and investigate cost-effective methods for incorporating welfare and sustainability in commercial broiler farming. Furthermore, research contrasting the environmental impacts of these housing types would yield significant insights into their wider ecological consequences.

CONCLUSION

This study revealed that housing systems affect broiler productivity, welfare, and mortality, providing essential insights for sustainable chicken farming. Controlled environmental systems demonstrated superior efficiency, with maximum weight growth (2500 g), lowest feed conversion ratio (1.75), and lowest mortality rate (4.8%), rendering them optimal for productivity-oriented operations. Free-range systems demonstrated superior facilitation of natural activities, achieving the highest behavioural scores (85), although they experienced elevated mortality rates (8.3%) attributable to environmental exposure. Conventional cages demonstrated the least efficacy, exhibiting the lowest productivity and welfare results, whereas deep litter systems offered a balanced methodology with moderate output and behavioural assessments. These findings emphasize the necessity of synchronizing housing systems with production and welfare goals. The study's limitations, such as its 42-day trial period, controlled environmental circumstances, and absence of exogenous variables like illness outbreaks, restrict the generalizability of the findings to many situations. To enhance knowledge, future research should investigate the long-term impacts of housing systems on broiler health, geographical disparities, and the environmental footprints of various systems. These findings hold practical significance for poultry producers and policymakers, highlighting the necessity for measures that amalgamate productivity, welfare, and sustainability. Although controlled habitats maximize output, enhancing free-range systems to decrease mortality could improve welfare. This study establishes a basis for future advancements in housing system design, harmonizing economic efficiency with ethical and environmental factors.

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