

# Case Study: Comparing the Welfare of Broiler Chickens in Two Intensive Production Systems in Israel

Plitman, L., Ben-Dov, D., Dolev, S., Katz, R., Miculitzki, M., Nagar, S., Markovich, M.P., Snir, I. and Honig, H.\*

Veterinary Services, Ministry of Agriculture and Rural Affairs, Israel

\* **Correspondence:** Dr. Hen Honig, Veterinary Services, Ministry of Agriculture and Rural Affairs, Israel; Email: henh@moag.gov.il

## ABSTRACT

For the purpose of growing chickens for meat (broilers) in Israel, it is common to house them in conventional deep litter. Recently, colony cages were introduced as an alternative housing system and the question of their impact on broiler welfare ensued. In order to evaluate and compare the broilers' welfare in both systems, the Welfare Quality® assessment protocol was used. Both systems scored high on almost all measurements. Hock burns were relatively low in both systems but significantly lower in the deep litter system, while plumage cleanliness scored significantly higher in broilers reared in colony cages. Overall, the broilers' welfare in the colony cages was not considerably impaired according to the examined measurements of the assessment protocol, and the pilot study did not find enough evidence to sanction the use of colony cages altogether. However, the authors concluded that these findings were insufficient in determining the overall impact this system has on the broilers' welfare, due to the limited examination of the behaviour of the broilers. Further research to accurately evaluate the systems' impact on broiler welfare is required.

**Key words:** Broilers; Welfare; Colony cages; Housing system; Production system.

## INTRODUCTION

Traditionally, broilers in Israel are reared on litter-bedded floors, in large flocks consisting of thousands of birds in one barn. Recently, a reservation has arisen regarding the use of modern multi-tier colony cages (CC) as an alternative to the conventional deep litter (DL) housing system. In order to evaluate the welfare of broilers reared in CC systems, the Welfare Quality® assessment protocol (WQP) (1) was used in a comparative pilot study. This protocol, the most widely used in Europe, was developed as part of the largest European research project on animal welfare (2). It emphasizes animal-based measures to assess the 'outcome' of the interaction between the animal and its environment, in the form of housing design and management (3).

Currently, Israel does not have specific regulations regarding the rearing of broilers and usually relies on European

legislation as general guidelines. European Council Directive 2007/43/EC, lays down minimum requirements for rearing broilers. The directive does not prohibit rearing broilers in cages but requires the provision of litter (4), which isn't provided in the CC in Israel. Reviewing the scarce published research on CC, accentuated the difficulty in drawing firm conclusions on the extent of the systems' impact on the broilers' welfare (5).

Therefore, an urgent need to examine the new caging system and its effect on the broilers' health, behaviour and overall welfare ensued, and served as the impetus for this preliminary study.

## MATERIALS AND METHODS

The WQP for poultry was used to compare animal-, resource- and management-based measures between two

housing systems – CC and DL. The assessment was carried out on two separate farms under the same management between April and May 2020. Day-old broiler chicks were purchased from the same commercial hatchery and randomly allotted to each farm, 15,800 in Farm A and 14,000 in Farm B. The broilers were slaughtered at 35 days, at a commercial slaughterhouse. The final slaughter body weight was 2.3 kg for broilers from farm A (DL) and 2.4 kg for broilers from farm B (CC).

Farm A consisted of a DL housing system, with an open-sided barn with wire mesh fences and pine wood-shavings litter (supplied by Menashe-Menashe wood-shavings supplier, Ltd.). The barn had a usable space of 1250m<sup>2</sup> (~0.08m<sup>2</sup> per broiler), with 288 feed pans and 1280 nipple drinkers. Farm B consisted of a CC housing system (Model Avina, Big Dutchman, Holland). Cages in the experiment were made of zinc-aluminum-coated wire with side opening grills, soft flexible plastic mesh flooring and a Polypropylene conveyor belt underneath. The netting floor was divided into pivoting sections that could open up to allow the broilers to fall onto the conveyor belt from a low height. The conveyor belt had a dual function: 1 – collecting the droppings and transporting them out of the coop. 2 – easy moving-out of the broilers with little or no human handling. The CC system consisted of 6 rows of 5-tier cages, with each tier divided into 4 compartments. Each compartment had a usable space of 3.7m<sup>2</sup> (~0.07m<sup>2</sup> per broiler), with 2 feed pans and 12 nipple drinkers. Each compartment was populated with 56 broiler chickens. The coop had a closed ventilation system with humidity and temperature monitoring and control.

Welfare measures were recorded on the farm and at the slaughterhouse while using the sample sizes specified in the WQP for animal-based measures; for each on-farm measures (Plumage cleanliness, Panting, Huddling), One hundred random birds were assessed from each farm (n=600). For each measure of injuries recorded in the slaughterhouse (Breast blisters, Hock burn, Footpad dermatitis), 100 random birds were examined from each farm (n=600). For measures of signs of diseases were recorded in the slaughterhouse (Emaciation, Ascites, Dehydration, Septicaemia, Hepatitis, Pericarditis, Abscess), slaughterhouse records of meat hygiene inspection process were used (n=8976).

Due to the difference between the two housing systems, namely the lack of litter in CC, measures of litter quality and

dust sheet test were excluded, as they were not comparable. Additionally, lameness was excluded as it could not be detected in the CC and therefore was not comparable.

The Avoidance distance test, indicating good human-animal relationship, was evaluated in the CC by standing next to a compartment, opening the side grill and reaching an arm into the cage for 10 seconds, while counting the number of birds within arm's length. This was done 21 times (as specified in the WQP), in different locations (different rows, tiers and compartments).

Data was analysed using the IBM SPSS Statistics Package. The Chi-squared test of independence was used to analyze ordinal data (plumage cleanliness, hock burn and footpad dermatitis [FPD]). The Fisher's exact test was conducted when chi-squared contingency tables had cells with expected counts of less than five. For all other measurements, the index (I) and score were reported according to the WQP ( $P \leq 0.05$  was considered as statistically significant).

## RESULTS

The WQP calculations of criteria scores for broilers for the two systems are presented in table 1. Overall, both systems scored high according to the WQP. Significant differences in criterion scores (Table 2) were measured for plumage cleanliness, with CC scoring significantly higher than DL ( $p=0.00$ ) and for hock burn, while DL scores were significantly lower ( $p=0.04$ ).

### Good Feeding

Both systems had a similar and low rate of emaciated birds (~0.1%). CC scored higher based on the criterion of absence of prolonged thirst (measured by drinker spacing), having a nipple per bird ratio of 1:4.6, while the DL system had a ratio of 1:12.3.

### Good Housing

The DL system scored higher on the ease of movement criterion, having a lower stocking density than the CC, and scored higher on thermal comfort, with no panting observed. Panting was observed in a few birds (4%) in the CC system, all located in the peripheral cages in the barn. No huddling was observed in either system. CC scored higher for plumage cleanliness.

**Table 1.** Criteria scores per housing system

Welfare Principle	Criteria	Measures	Scores			
			Farm A (DL)		Farm B (CC)	
			I	Score	I	Score
Good Feeding	Absence of prolonged hunger	Emaciation	98.5	90.8	98.4	89.9
	Absence of prolonged thirst	Drinker space	33.9	65.1	111.5	102.2
Good Housing	Comfort around resting	Plumage cleanliness	37.8	24.3	98.8	95.4
	Thermal comfort	Panting, Huddling	n/a	100	n/a	69
	Ease of movement	Stocking density	37.3	51.6	19.1	35.6
Good Health	Absence of injuries	Breast blisters	100.0	99.4	100.0	99.4
		Hock burn	91.8	49.0	88.0	41.7
		Footpad dermatitis	98.9	93.9	98.3	91.0
	Absence of diseases	Ascites, Dehydration, Septicaemia, Hepatitis, Pericarditis, Abscess, Mortality	100	100	100	100
Appropriate Behaviour	Good human-animal relationship	Avoidance distance test	14.7	86.8	51.0	94.2
	Positive emotional state	Qualitative behavioural assessment	-3.0	18.9	-5.5	17.3
<b>Total score</b>			<b>779.8</b>		<b>835.7</b>	

**Table 2.** Comparison of ordinal measures per housing system

Measures	Scores*					$\chi^2$ test/FET**	p-value					
	Farm A (DL)							Farm B (CC)				
	0	1	2	3	4			0	1	2	3	4
Plumage cleanliness	1	20	43	36	n/a	92	8	0	0	n/a	$\chi^2 = 173.2$	0.00
Hock burn	67	24	7	2	0	48	39	11	2	0	FET=7.7	0.04
Footpad dermatitis	96	4	0	0	0	93	5	2	0	0	FET=1.8	0.50

\* For each measure, 100 birds were assessed from each farm.

\*\* FET – Fisher's Exact Test

n/a Not applicable

### Good Health

Both systems were found to have a low occurrence of breast blisters, FPD and hock burns, though DL scored higher than CC on hock burns. Both systems had low incidences of disease and on-farm mortality.

### Appropriate Behaviour

Both systems scored high on good human-animal relationship measured by avoidance distance, and similarly on the Qualitative Behavioural Assessment.

## DISCUSSION

The objective of this study was to evaluate the CC systems' impact on broilers' welfare compared to the conventional DL

systems, and consequently determine whether to censure the use of CC systems in Israel.

The apparent advantage of the CC is their automatic manure disposal systems which allows daily manure removal to reduce ammonia emissions, and for the birds to be transported to the collecting point with little or no human contact (5). Compared to the gathering and capture routine of broilers in DL systems, the stress caused to birds during marketing was very limited. Furthermore, the soft, flexible polymer flooring of the CC may have assisted in preventing certain health conditions associated with either metal wire flooring in conventional battery cages or the effect of ammonia accumulation in the litter in DL systems (6,7). The potential disadvantage of CC systems may have been the movement restriction due to the smaller size of the cage compared to an open barn, and

the absence of litter, not allowing for normal behaviours to be performed, such as pecking and dust bathing (8,9). However, these behaviours have been studied mainly in laying hens, and little scientific research is available on the ability and motivation of the fast-growing, mostly inactive broilers to perform them (10), and specifically in the context of CC.

Comparing measurements of both farms according to WQP, plumage cleanliness scores were significantly higher in broilers reared in CC. This was observed in other studies and may be attributed to the system's absence of litter (11, 12). Wet or cakey litter results in dirty plumage and negatively affects the broilers' welfare, as they spend most of their time in close contact with the litter, either sitting or lying (7). Moreover, plumage cleanliness may signal broilers' general health condition, with healthy broilers having clean and shiny feathers while sick or injured ones tend to have soiled plumage (13).

Hock burns, a type of contact dermatitis, were found to be relatively low in both systems but significantly lower in the DL system. Hock burns have been linked to litter quality and moisture levels in DL systems (14,15), but have not been thoroughly examined in studies on caged broilers. Other factors which have been found to affect the severity and frequency of contact dermatitis, are management and housing conditions such as stocking density, temperature, ventilation, feed deficiencies and floor permeability (14, 16). Therefore, this finding may possibly point to a potential negative impact of the CC system on the broilers' welfare. However, no significant differences between systems were observed in other measurements of contact dermatitis. i.e., FPD and breast blisters, which do not necessarily indicate an inherent problem with the cage floor. Indeed, Zhao *et al.* found that broilers reared on plastic-floored cages had a significantly lower occurrence of breast blisters compared to wire floors, which suggested plastic is a less abrasive netting material (6). Another consideration to be made is that the differing stocking densities between the farms (12.6 birds/m<sup>2</sup> for DL vs. 15.3 birds/m<sup>2</sup> for CC), skewed the housing criterion scores and may have acted as a confounding factor. While these stocking densities are commercially common for each respective system, to better understand the impact each housing system has on the broilers' welfare, similar stocking densities should be used, as they are a variable related to management practices and not an inherent feature of the system itself.

Both systems scored high on almost all measurements, with lower scores mostly belonging to resource-based mea-

asures (e.g., birds per nipple drinker in the DL system and stocking density in the CC system). This could be improved by simple management processes (such as adding drinkers and lowering the stocking density), without affecting the integral part of the housing system. However, some measurements that could indicate a possible negative effect of the housing system on broiler behaviour (e.g., litter quality) were partial and therefore could not provide a full picture of the impact of CC on the welfare of broilers.

Overall, the broilers' welfare in the cage system was not considerably impaired according to the examined measurements of the WQP, and the pilot study did not find enough evidence to censure the use of CC altogether.

## CONCLUSIONS

In this study, both systems overall scored high on the Welfare Protocol Assessment, indicating no significant welfare impairments according to the parameters examined. However, this finding is insufficient in determining the overall impact of the CC system on the broilers' welfare. The behavioural examination was limited, and the absence of litter and restriction of movement of the broilers could not be thoroughly studied. Correlation between all parameters is crucial for adequate welfare assessment, bearing in mind the parameter's evaluation factors. A comprehensive comparative study, investigating the utilization of litter and available space in both systems (including the broilers' motivation and ability to perform normal behavioural patterns and considering genetic restrictions), is required.

## DECLARATIONS

**Acknowledgements:** We would like to thank Ohad Tzuri for his help and support throughout the study.

**Compliance with Ethical Standards:** The study was approved by the Ministry of Agriculture Ethics Committee.

**Conflicts of Interests:** The authors confirm that there are no known conflicts of interest associated with this publication.

**Funding:** No funding was received for conducting this study.

**Availability of data and material:** The data that support the findings of this study are available from the corresponding author, [H.H.], upon reasonable request.

## REFERENCES

1. Butterworth, A., van Niekerk, T.G.C.M., Veissier, I. and Keeling, L.J.: Welfare Quality Assessment protocol for Poultry, 2009. <http://www.welfarequalitynetwork.net/media/1293/poultry-protocol-watermark-6-2-2020.pdf> (Accessed 02 June 2021).
2. Blokhuis, H.J., Veissier, I., Miele, M. and Jones, B.: The Welfare Quality® Project and Beyond: Safeguarding Farm Animal Well-being. *Acta. Agric. Scand.* 60:129-140, 2010.
3. De Jong, I.C., Gunnink, H. and Hindle, V.: Implementation of the Welfare Quality® Broiler Assessment Protocol – Final Report, 2014. <https://edepot.wur.nl/339412> (Accessed 11 June 2021).
4. European Union (EU). Council Directive 2007/43/EC of 28 June 2007 Laying Down Minimum Rules for the Protection of Chickens Kept for Meat Production. *Off J Eur Union*, 2007. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32007L0043> (Accessed 16 April 2021).
5. Mench, J., de Jong, I. and Butterworth, A.: Influences of Housing and Management on Broiler Welfare. In: X. M. Vilanova (ed.), *Broiler Chickens: Welfare in Practice*, (5M Books Ltd.), 54, 2021.
6. Zhao, F.R., Geng, A.L., Li, B.M., Shi, Z.X. and Zhao, Y.J.: Effects of Environmental Factors on Breast Blister Incidence, Growth Performance, and Some Biochemical Indexes in Broilers. *J. Appl. Poult. Res.* 18: 699-706, 2009.
7. De Jong, I.C., Gunnink, H. and Van Harn, J.: Wet Litter Not Only Induces Footpad Dermatitis But Also Reduces Overall Welfare, Technical Performance, and Carcass Yield in Broiler Chickens. *J. Appl. Poult. Res.* 23: 51-58, 2014.
8. Duncan, I.J.H.: The Pros and Cons of Cages. *World Poult. Sci. J.* 57: 381-390, 2001.
9. Shields, S. and Greger, M.: Animal Welfare and Food Safety Aspects of Confining Broiler Chickens to Cages. *Anim.* 3: 386-400, 2013.
10. Bokkers, E.A.M. and Koene, P.: Motivation and Ability to Walk for a Food Reward in Fast- and Slow-growing Broilers to 12 Weeks of Age. *Behav. Processes.* 67: 121-130, 2004.
11. Çavuşoğlu, E., Petek, M., Abdourhamane, İ.M., Akkoc, A. and Topal, E.: Effects of Different Floor Housing Systems on the Welfare of Fast-growing Broilers with an Extended Fattening Period. *Arch. Anim. Breed.* 61: 9-16, 2018.
12. Farghly, M.F.A., Mahrose, K.M., Cooper, R.G., Ullah, Z., Rehman, Z. and Ding, C.: Sustainable Floor Type for Managing Turkey Production in a Hot Climate. *Poult. Sci.* 97: 3884-3890, 2018.
13. Linares, J.A., Dougherty, S. and Millman, S.: Poultry Welfare Assessment on the Farm: Focusing on the Individual. In: J. A. Mench (ed.), *Advances in Poultry Welfare* (Woodhead Publishing), 131-148, 2017.
14. Tucker, S.A. and Walker, A.W.: Hock Burn in Broilers. In: P.C., Garnsworthy, W., Haresign, D.G.A., Cole (eds.), *Recent Advances in Animal Nutrition* (Butterworth-Heinemann), 33-42, 1992.
15. Sirri, F., Minelli, G., Folegatti, E., Lolli, S. and Meluzzi, A.: Foot Dermatitis and Productive Traits in Broiler Chickens Kept with Different Stocking Densities, Litter Types and Light Regimen. *Ital. J. Anim. Sci.* 6: 734-736, 2007.
16. Hocking, P.M. and Veldkamp, T.: Contact Dermatitis in Domestic Poultry. In: O.A., Olukosi, V., Olori, A., Helmbrecht, S., Lambton, and N., French, (eds.), *Poultry Feathers and Skin: The Poultry Integument in Health and Welfare* (CABI), 70-83, 2017.