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RESPONSE OF NICHOLAS WHITE TURKEYS TO INDOOR–OUTDOOR REARING SYSTEMS, GROWTH PERFORMANCE AND WELFARE PARAMETERS

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ABSTRACT

The experiment investigated the response of Nicolas White Turkeys reared under indoor and outdoor housing systems. 46-day-old poults were obtained from a reputable commercial hatchery, and the poults were reared for 4 weeks. The poults were placed in a 2 x 2 factorial arrangement in a completely randomized design (CRD). The results of the study revealed significant differences ($P < 0.05$) between male and female turkeys in terms of pecking and walking behaviour. About housing and its interaction, the result revealed that there were no significant ($P>0.05$) differences across all parameters. The result of the human approach test indicated that all indices evaluated were not influenced by sex and housing at varying levels of time, except at 60 seconds, where a significant ($P<0.05$) difference was recorded with female turkeys having the highest indices of exploration. The higher indices recorded on female turkeys at 60 seconds might be attributed to feminine attitudes in protecting their younger ones. In addition, the first-to-touch (F.T.) values obtained do not differ significantly between the sexes. The result of sex and housing on transect walks and novel environments indicated that there were no significant differences ($P>0.05$) across all the treatments evaluated. However, escape attempts were significantly ($P<0.05$) affected by sex, with females having a higher frequency of escape attempts. This might be attributed to active defence and active avoidance, and it's the stimulation of the sympathetic nervous system that prepares the individual for fight, flight/escape attempts, or fright.

Keywords: vocalization, ambulation, novel environment, latency to vocalize, behaviour

INTRODUCTION

Nicholas white (*Meleagris gallopavo*) is adaptable to a wide range of climatic conditions and can be raised successfully almost anywhere in the world (Odutayo *et al.,* 2015). The turkey industry in Nigeria has risen from 1.5 to 2 million tons of meat locally per annum. This rapid growth in the industry was made possible by intensification of production and development of large breeds with standard live weights ranging from 15 to 17 kg for males and 8 to 10 kg for females at 15 to 16 weeks of age, some of which was produced from homesteads (Oyeagu *et al.,* 2022). Its production is carried out in all parts of the country with little or no religious, social, or cultural inhibitions associated with its consumption (Oyeagu *et al.,* 2022). Consumers currently demand livestock and poultry products originating from animals raised under optimum welfare conditions (Bartussek, 1999; Special Eurobarometer, 2016). In addition, an increasing number of farmers recognized the importance of full compliance with animal welfare standards, which can play an important economic role in commercial production. Increased public concerns about animal welfare have directed consumers' attention to meat from poultry reared in low-input systems, considered by them to be more sustainable and superior for bird welfare (Erian and Phillips, 2017). In Nigeria, there is no known discriminatory legislation against the production of turkey and consumption of its meat, but they are very difficult to find (Olajide *et al.,* 2015).

Several welfare issues in turkey production were reported to include poor leg health and mobility problems, feather pecking and aggression toward flock mates (Dalton *et al.,* 2013), wounds, infections, and contact dermatitis (Krautwald-Junghanns *et al.,* 2011; Mitterer-Istyagin *et al.,* 2011). Leg and wing problems associated with bone weakness are prevalent in large-sized poultry like turkeys, which render them lame, leading to the deterioration of their gait conditions, performance, and welfare (Zhou *et al.,* 2011). Poor leg health may be associated with both infectious and non-infectious factors and can cause commercial loss through increased mortality, culling, and reduced performance, which significantly affect profits of producers (Butterworth, 1999; European Food Safety Authority, 2012). High on-farm mortality can thus be an indicator of poor flock health, but may also reflect careful selection for culling by the stockperson (Muri *et al.,* 2023).

Therefore, a modern and sustainable poultry production must encompass acceptable welfare standards for animals. The demand for better-tasting meat, improved animal welfare, and environmentally friendly production has led to the modification of production systems practiced in Europe and the United States. One of the sought-after alternative rearing systems is the free range, which is already widely practiced in most rural areas in Nigeria. Keeping the litter, pen, and range areas dry is an important part that pays big dividends in the health of a growing turkey. In addition, clean stock, clean premises, and good management are the best lines of defence (Marsden and Holmes, 2016). Cheaper production and management strategies and establishing changes in the production system can improve poultry performance. The ability for producers to monitor bird welfare can have

important impacts on their economic revenue (Schrider, 2013). Poultry products derived from free-range or organic production are very popular sources of food, with consumers preferring these poultry products because they believe that the products have a superior sensory quality and meat security coupled with high standards of animal welfare (Tong *et al.*, 2014). Consumption of free-range chicken meat has increased, partly driven by consumer belief that access to an outdoor range is good for chicken welfare. A gradual increase in the human population and high cost of production have led to an increase in the prices of animal proteins (Rabie *et al.,* 2017). One of the possible solutions to these problems is searching for cheaper production and management strategies. Researchers have established that changes in production systems can improve poultry performance, hence, the best rearing system that conforms to the code of practice for the care and handling of poultry species should be adopted (Rabie *et al.,* 2017).

Materials and Methods

Experimental site

The experiment was conducted at the Poultry Unit of Professor Lawal Abdu Saulawa Livestock Teaching and Research Farm, Department of Animal Science, Federal University, Dutsin-Ma, Katsina State, Nigeria. Dutsin-Ma is a Local Government Area in Katsina State, North-western Nigeria. It lies on Latitude 12.27 °'18'N, Longitude 07.29°'29'E, with the onset of rainfall starting from March and ending by October. The average yearly rainfall is about 553mm, with an annual temperature ranging from 29°C - 45°C (Nimet, 2024).

Experimental Animals, design and management

A total of 46-day-old poults were obtained from a reputable commercial hatchery company, and the birds were reared for 4 weeks indoors (brooding). Upon arrival, the brooding pen was prepared with all brooding materials. At the end of the brooding phase (4 weeks), the poults were placed in a 2 x 2 factorial arrangement in a completely randomized design (CRD). The factors are two housing systems: deep litter without outdoor (DL - O) access and deep litter with outdoor access (DL + O), and two sexes (jakes and hen poults). The poults were separated according to sex and were allocated randomly to the two housing systems. The treatments allocated are as described below:

Treatment 1: Jake's under deep litter housing (JDL)
Treatment 2: Jake's under deep litter housing (JDLO)
Treatment 3: Hen poults under deep litter housing (HpDL)
Treatment 4: Hen poults under deep litter housing (HpDLO) respectively.

All the birds were given the same feed types *ad libitum,* containing 30% CP and 2800 ME kcal/kg at weeks 0 to 8 (starter phase) and 23% CP and 3000 ME kcal/kg at weeks 8 to 16 (grower phase) according to recommendations of AOAC (2000).

Data Collection

Growth Performance:

The following parameters were measured and recorded to determine the growth performance characteristics.

Body weight and body weight gain:

The body weight of the turkeys was taken at the beginning of the study and fortnightly. Initial and final weights and total body weight gain were determined and recorded.

BWG = Final body weight – Initial body weight

Feed intake:

A measured quantity of feed was allocated every week to each of the groups of poults and fed daily. Feed was weighed to determine weekly feed intake and daily feed intake.

Feed given (g) – leftover (g)

Feed conversion ratio:

The feed conversion ratio was determined by calculating the ratio of feed intake to weight gain.

$$\text{Feed conversion ratio (g/g)} = \frac{\text{Feed intake (g)}}{\text{Body weight gain (g)}}$$

Mortality:

Mortality was recorded as it occurred, and percentage mortality was determined as reported by A Greener World (2023).

$$\textbf{Mortality (\%)} = \frac{\text{Number of dead turkeys}}{\text{The initial number of turkeys at the start of the experiment}} \times 100$$

Carcass measurements

Three turkeys from each treatment were randomly selected at 16 weeks of age. The turkeys were fasted for 10 hours, however, with access to drinking water. Before slaughtering, live weight (LW) was recorded. The carcasses were then scalded in hot water for about 2 minutes to facilitate manual plucking. The following parameters were then measured and recorded; dressed weight (DW), wing weight (WW), back weight (BW), breast weight (BRW), thigh weight (TW), shank weight (SW), neck weight (NW) and head weight (HW) Internal organs (edible and non-edible) was removed and weighed.

Welfare Assessment:

Behavioural observations

Behavioural observations of turkeys in each pen were made at 6, 12, and 16 weeks of age. Focal sampling was used to measure the frequency of behavioural events. The observations were carried out by observers who stood in front of each replicate, with the first five minutes used for the adaptation of toms and hens to their presence. After the adaptation period, each observer conducted focal sampling continuously for 5 minutes on all turkeys per pen. The toms and hens were chosen at random and marked at least a week before with a marker for easy identification. Data were summed to give the frequency of each behaviour performed per tom and hen per 5-minute period as reported by Ferrante *et al*. (2019).

Novel environment test (NET)

Two poults from each replicate were used for this test at 8 and 16 weeks. Poults were individually placed on a square test arena, which had tiles with a grid of 25 squares. The walls of the test arenas were high enough to prevent any escape attempt by the poults. Each poult was placed in the centre of the test arena for 5 minutes. Direct observations were used to obtain six real-time behavioural data points. The six real-time behavioural data were: latency to ambulate; latency to vocalize; number of vocalizations; number of squares entered; number of times defecated, and escape attempt.

Note: Latencies to ambulate and to vocalize were measured in seconds.

Human Approach Test:

The human approach (HA) test was carried out at 14 weeks of age. The observer walks into each replication pen and stands for 3 minutes. During the test, the number of turkeys within a line of 0.5m in front of the observer was counted after every 30 seconds. The latency of the first turkey to touch the boots of the observer was recorded.

Novel Object Test:

A novel object test (NO) was performed on the same day as the human approach test (at 14 weeks). Neophobia of the poults was measured in a widely used assessment in which an unfamiliar but neutral object was presented to the assessment of individual poults. The parameter used, as the NO, was a silver bowl that was circular with a diameter of 8cm. The silver was placed on the floor, and the observer exited the pen and observed from outside. The turkeys were observed for 3 minutes during which the latency of the first turkeys to approach (<25cm) and the latency of the first approach to touch the object were recorded. In addition, the observer counted the number of turkeys within a 25cm line away from the novel object after every 30 seconds.

Transect Walk:

The house that was used in this study was rectangular, 14m wide, and with a length of 70m long. The house was divided into 2 longitudinal transects (2m wide paths) covering the length of the house. The house was divided into 22 pens ($2m^2$ each), with 12 having access doors to free range. During the transect walk, all the access doors were closed to prevent the turkey from escaping to the range area until the assessment was over. Two assessors were trained on the data collection method and welfare assessment of the selected indicators. The observations by the assessors were conducted sequentially and independently on the same day. Data collection was performed by walking through the predefined transect path in random order, in both directions, starting from the entrance wall and alternating the starting point for each transect. The assessors walked slowly while recording the number of turkeys showing any of the welfare indicators according to Marchewka *et al.* (2015). An assessor walked along the predetermined paths, counting the incidences of turkeys representative of predefined welfare indicator categories: immobile, lameness, head wound, vent, or back wounds, featherless, dirty, sick, terminally ill, or dead.

Range Use

Daily range use in the morning and afternoon was evaluated throughout the research period. The assessor entered the research pen and carefully recorded the number of turkeys inside and outside the pens with access to the outdoors.

Statistical Analysis

All data generated was analyzed using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) package version 9.2 software (Statistical Analysis System, 2007, SAS Institute Inc., Cary, NC, USA), and statistical significance was set at $P<0.05$. Statistical difference was separated using Duncan's Multiple Range Test method in the software.

Results and discussions

The result of this study, as revealed in Table 1, indicated that there were significant ($P<0.05$) differences between the sexes of the turkeys in terms of final body weight, weight gain, and total feed intake. The males have the highest values compared to the female turkeys. This is in contrast with the findings of Suleiman (2023), who reported that there was no significant difference ($P > 0.05$) between DL and O+P (*Lablab purpureus*) in terms of final body weight and body weight gain of Noiler birds reared under different housing types (DL: 1.64 & O+P: 1.64). Similarly, there are no significant differences in terms of total feed intake (TFI) among all the treatments (Suleiman, 2023). Except for feed conversion ratio and mortality rate (FCR= 2.17 – 2.56% & Mort= 10.00 – 3.33%), which indicated an insignificant statistical difference between the two sexes. For the housing, initial body weight and total feed intake show significant ($P > 0.05$) differences between the treatments. This means that final body weight, weight gained, feed conversion ratio, and mortality are statistically the same. Animals will have a higher energy demand living outside because they are expending more energy walking around and using more energy to stay warm/cool.

Table 1: Assessment of Performance of broiler turkey raised on indoor and outdoor housing systems

Parameters	IBW	FBW	WG	TFI	FCR	MORT
Sex						
Male	4.24[a]	11.52[a]	7.28[a]	15.60[a]	2.17	10.00
Female	3.66[b]	9.54[b]	5.88[b]	14.78[b]	2.56	3.33
SEM	0.17	0.34	0.36	0.24	0.17	4.08
Housing						
Indoor	4.04	10.62	6.58	15.10	2.31	6.67
Outdoor	3.86	10.43	6.58	15.28	2.42	6.67
SEM	0.17	0.33	0.36	0.24	0.17	4.08
Interaction						
Sex * Housing	NS	NS	NS	NS	NS	NS

[a-b] means within rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means, IBW: initial body weight, FBW: final body weight, WG: weight gain, TFI: total feed intake, FCR: feed conversion ratio, and MORT: mortality.

Effect of sex and housing on behavioural parameters of Nicholas white turkeys

The effect of sex on behavioural indices of Nicholas white turkeys, as shown in Table 2, indicated that there were significant differences ($P < 0.05$) between male and female turkeys in terms of pecking and walking behaviour of turkeys. The result of this study further indicated that male turkeys have a higher prevalence of pecking and walking behaviour than female turkeys. Buchholz (1997) tries to justify how pecking was learned in the wild, he explained that head pecking is learned by young birds as a fighting technique used by mature birds to determine the "pecking order". Furthermore, pecking under commercial production conditions is typically caused by aggression owing to stress or social disturbance Moinard *et al.*, 2001). Marchewka *et al.* (2019) found a positive association between high stocking density and pecking.

The result of this study conformed with the findings of Dalton *et al.* (2013), who stated that head pecking was found to be more frequent in sexually mature toms than in hens. Compared with laying hens, relatively few studies have focused on injurious pecking in domestic turkeys (Dalton *et al.*, 2013). In addition, Dalton *et al.* (2018) also clarify that only two studies attempted to describe the behavioural characterization of pecking, indicating that turkeys engaged in pecking were more active with shorter lying durations and less frequent standing than turkeys performing severe feather pecking or gentle feather pecking. Marchewka *et al.* (2020) further found that no studies were found relating pecking to physical characteristics of turkeys, such as their size. Injurious pecking (head wounds) is considered an important economic issue as denuded birds experience increased heat loss and require additional feed intake to maintain thermoregulation (Appleby *et al.,* 2004).

The findings of Jibia (2021) conformed with the findings of the present study, where she discovered an insignificant increase in the standing behaviour of birds. Similarly, the result obtained in this study about walking behaviour is in agreement with her findings, where she recorded a significant increase in walking behaviour in birds. The findings of Jibia (2021) contradict the outcome of this study, who reported that eating and drinking behaviour were significantly higher across all the treatments. Research on the assessments of different housing systems on turkeys' behaviour and their interactions from a welfare point of view is still scarce (Marchewka *et al.,* 2013b). According to Marchewka *et al.* (2013b), who reported that turkeys may show large behavioural adaptation as a response to inadequate environmental conditions. In contrast to the present study, Ferrante *et al.* (2019) established in their findings that, males' turkeys usually achieved 20kg average body weight at 140 Days of age, whereas females will reach 9kg average at 100 days of age. It's obvious that adult male turkeys have a larger body weight than females; this could lead to a higher prevalence of degenerative hip disorders, which will result in a state of chronic pain and low movement. Furthermore, they concurrently maintained those male turkeys spent less time standing or walking, showing longer lying periods which could lead to a higher presence of breast buttons and blisters.

The effect of housing on turkeys' behaviour as presented in Table 2 revealed that there were no significant ($P>0.05$) differences across all parameters. The result of this study conforms with the findings of Suleiman *et al.* (2024), who found that there is a significant difference ($P<0.05$) between deep litter and outdoor pasture in terms of comb pecking. Similarly, Jibia (2021) findings revealed that there were no significant differences in panting. In addition, pecking behaviour in her findings shows significant differences where the majority of pecking incidences were observed in birds with outdoor access (Jibia, 2021). In addition, Zhao *et al.* (2014) recorded that no significant difference was found in feeding and drinking between the two systems.

However, the sitting and preening behaviours observed in this study were not in conformity with the findings of Jibia (2021), who recorded a significant increase in both sitting and preening behaviour of both indoor and outdoor systems. Similarly, this result is not in agreement with Baracho *et al.* (2012), who reported a negative relation between the use of outdoor and walking difficulties and the relations between toe damage and asymmetry with walking difficulties, reduced mobility, and reduced possibility to access resources. Previous studies suggested that providing chickens with a more complex environment, such as outdoor, pasture, and other enrichment in the environment, is likely to improve bird welfare, both by improving feed intake, leg health, and by providing a stimulating environment to promote natural behaviours (Newberry, 1995).

Table 2: Effect of different housing and sex on behavioural indices of Nicholas white turkeys (number)

	Parameters								
Behaviour	Eating	Drinking	Panting	Preening	Resting	Pecking	Sitting	Walking	Standing
Sex									
Male	4.88	5.87	11.70	7.77	12.12	12.89[a]	9.02	19.18[a]	17.14
Female	8.66	7.24	11.87	7.20	16.39	4.33[b]	15.56	12.36[b]	15.83
SEM	2.70	1.90	1.68	1.25	2.71	1.41	3.31	1.05	2.33
Housing									
Indoor	4.95	7.78	12.27	5.81	17.69	7.71	12.24	15.40	16.16
Outdoor	8.60	5.33	11.30	9.20	10.83	9.51	12.33	16.14	16.81
SEM	2.70	1.88	1.70	1.25	2.71	1.41	3.31	1.05	2.33
Interaction									

Sex * Housing	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a-b] means that the rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means.

Effect of sex and housing on the human approach test of Nicholas white turkeys

The evaluation of the human approach test as a welfare indicator, as presented in Table 3, indicates that all indices evaluated were not influenced by sex at varying levels of time except at 60 sec. Where significant (P<0.05) difference was recorded in female turkeys having the highest indices of exploration. The higher indices recorded on female turkeys at 60 sec might be attributed to feminine attitudes in protecting their younger ones. In addition, the first to touch (F.T.) values obtained do not differ significantly between the sexes. The values of FT signified that females are more neophobic than male turkeys. Usually, female birds use darker environments while laying eggs and are always frightened by hawks and other predators that seek to kill their younger ones. Kulke *et al.* (2021) report contradicting the result obtained in this study, Kulke *et al.* (2021) recorded a significant influence in sexes of turkeys. Authors further stated that compared to male turkeys. The female showed shorter latency time until the first touch. This assertion is not in conformity with the findings of the present study.

The human approach test performed was used to assess the latency of animals to approach a motionless human observer. Moreover, the result of this study with regard to housing systems and their interactions does not significantly (P>0.05) influence fearfulness of the turkeys to approach the observer. The result of this study did not agree with the result of Suleiman *et al.* (2024), where they reported a significant difference between outdoor and deep litter housing systems in broiler chickens. In addition, Jibia (2021) recorded a significant difference in the test at 60, 120, and 180 seconds. However, during complex fear-related responses, it is unlikely that a specific behaviour is solely caused by one emotion, i.e., fear (Forkman *et al.*, 2007).

Table 3: Effect of different housing and sex on human approach test of Nicholas white turkeys (number

	Parameters							
Treatments	30Sec	60Sec	90Sec	120Sec	150Sec	180Sec	210Sec	F.T
Sex								
Male	1.33	1.50[b]	1.33	1.33	1.50	1.33	2.00	100.00
Female	1.67	2.33[a]	2.17	2.17	2.50	2.50	2.67	81.67
SEM	0.46	0.24	0.33	0.54	0.51	0.75	0.77	7.73
Housing								
Indoor	1.83	2.00	2.33	2.33	2.50	2.50	3.00	100.00
Outdoor	1.17	1.83	1.17	1.17	1.50	1.33	1.67	81.67
SEM	0.46	0.24	0.33	0.54	0.51	0.75	0.77	7.73
Interaction								
Sex * Housing	NS	NS	NS	NS	NS	NS	NS	NS

[a-b] means that within rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means, Sec: Second, F. T: first touch

Effect of sex and housing on the novel object test of Nicholas white turkeys

The use of novel objects to evaluate fear in turkey husbandry and to investigate the reaction of male and female turkeys to novel objects was assessed. Table 4 indicates that there were no significant (P>0.05) differences across all the parameters used for this study, except the novel object test at 150 sec. Where a significant (P<0.05) difference was recorded with male turkeys having a higher percentage than female turkeys. Male turkeys' behaviour on NO showed less neophobia than female turkeys. The reason for females to be more neophobic might be attributed to their ability to protect their younger ones against predators.

The result of Lendvai *et al.* (2010) conforms with the findings of the present study; they recorded non-significant differences between male and female turkeys in terms of neophobia, except at 150 sec, where the male turkeys varied significantly from the female turkeys. Kulke *et al.'s* (2021) discovery is in agreement with this finding, where they recorded a significant difference in males showing longer latencies to approach the object in week 5 as compared to all other time points.

The findings of Kulke *et al.* (2021) contradict the result of this study, where they recorded that none of the parameters were affected by the novel object present. Sex effects were found to be significant for all parameters measured (all $F > 107.2$; all $p < 0.001$), with females showing shorter latency times until the first peck and the first approach, a higher pecking frequency, and more animals approaching the object.

The effect of housing on a novel object on turkeys was investigated and presented in Table 4. The result of the study revealed that there were no significant (P>0.05) differences across all the treatments investigated. This implies that housing systems employed in this study do not significantly influence the neophobia of turkeys about the novelty test conducted during the research. Based on the above findings, it can be recommended that local farmers can rear turkeys in either semi-intensive, extensive, or intensive systems of management without fear of novelty that might tend to inflict neophobia on the turkeys reared. The result of this study is in agreement with the findings of Suleiman *et al.* (2024), who recorded insignificant differences between indoor and outdoor housing types in Noiler birds. On the contrary, Bari *et al.*

(2021) found that pullets reared in more complex aviary environments approached novel objects more as young adults compared with cage-reared hens.

Table 4: Effect of different housing and sex on the novel object test of Nicholas white turkeys (number)

	Parameters							
Treatments	30Sec	60Sec	90Sec	120Sec	150Sec	180Sec	210Sec	F. T
Sex								
Male	3.83	2.50	2.67	2.33	2.83[a]	1.83	1.83	130.00
Female	2.83	2.00	3.17	1.67	1.50[b]	1.50	1.00	120.00
SEM	0.50	0.52	0.33	0.60	0.41	0.51	0.58	15.09
Housing								
Indoor	3.67	2.83	2.83	2.33	2.83	2.33	2.00	143.33
Outdoor	3.00	1.67	3.00	1.67	1.50	1.00	0.83	106.67
SEM	0.50	0.53	0.33	0.60	0.41	0.51	0.58	15.09
Interaction								
Sex * Housing	NS	NS	NS	NS	NS	NS	NS	NS

[a-b] means that within rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means, Sec: Second, F. T: first touch.

Effect of sex and housing on the transect walk of Nicholas white turkeys

The effect of sex on the transect walk of turkeys was assessed and presented in Table 5. The result indicated that there were no significant differences (P>0.05) across all the treatments evaluated. The result of the study conformed with the findings of Marchekwa *et al.* (2015), who reported that interaction between the observer and the animal did not affect the incidences of the welfare indicators, except immobility, as evaluated using a transect walk. However, they recorded a contradicting result about immobility scores, where they observed significant differences across the treatments for the incidence of immobile turkeys in a very small numerical terms Marchekwa *et al.*, 2015). Male turkeys, as expected, were more affected by immobility, lameness, head and tail wounds, and dirtiness than female turkeys. These could be considered one of the critical indicators for assessing the welfare status of the turkeys. The recorded gender differences might be attributed to the differences in weight of male and female turkeys as reported by Ferrante *et al.* (2019).

In practice, the farm animal welfare council supported the idea of the transect walk in turkeys as one of the most reliable, practicable, efficient, and easy to apply method for an on-farm assessment of turkey welfare. Despite the importance of this new approach regarding its reasonable costs, its also less time-consuming and minimally invasive for the turkey's production. In addition, a major advantage is that the method does not involve bird manipulation, which would be a major challenge in turkey rearing as investigated by Marchewka *et al.* (2015). Under the conditions of this study, the results indicate that the transect walk was highly sensitive to detect differences in the prevalence of welfare indicators among male and female turkeys.

Lameness and other welfare indicators have obvious implications for the welfare of turkeys (Kamyab, 2001) but also have a negative impact on the economic revenue for the farmer. Relationship between the prevalence of lameness, immobility, and carcass quality was reported by Marchewka *et al.* (2015). Marchewka *et al.* (2015) found a very high correlation between the prevalence of leg disorder and the prevalence of condemnations and other carcass quality indicators.

The effect of housing systems on the transect walk has been investigated and recorded in Table 7. The result obtained on housing systems of turkeys and their interactions shows that there were no significant (P>0.05) differences among all the treatments. This implies that housing systems do not affect or influence turkeys' welfare. The report of Marchewka *et al.* (2024) is in agreement with this finding, where they reported that there were no significant differences across all the treatments assessed using a transect walk to evaluate the neophobia of birds. However, the result of Marchewka *et al.* (2020) contradicts the finding of the present study, they documented that more terminally ill turkeys were found outdoors than indoors. In addition, Animal Welfare Indicators indicated that there was a significant difference across houses for all the evaluated indicators. These results may be due to the difficulties in assessing these parameters equally while walking by the observer (AWIN, 2014). These preliminary findings suggest that this new approach has potential as a tool for on-farm welfare evaluation, which may be worthwhile to further develop (Marchewka *et al.,* 2020).

Table 5 Effect of different housing and sex on the transect walk of Nicholas white turkeys (number)

	Parameters							
Treatments	Dirtiness	H. W.	Immobile	Lameness	Sick	T. Ill	Dead	Aggression
Sex								
Male	2.67	1.67	0.00	0.00	0.00	0.00	0.17	0.83
Female	1.33	1.83	0.17	0.17	0.17	0.17	0.17	0.33
SEM	0.79	0.17	0.12	0.12	0.12	0.12	0.17	0.33
Housing								
Indoor	1.67	2.00	0.17	0.17	0.17	0.17	0.17	0.83
Outdoor	2.33	1.50	0.00	0.00	0.00	0.00	0.17	0.33
SEM	0.79	0.17	0.12	0.12	0.12	0.12	0.17	0.33
Interaction								
Sex * Housing	NS	NS	NS	NS	NS	NS	NS	NS

[a-b] means that within rows bearing different superscripts differ significantly at $p > 0.05$; SEM: Standard error of means, Sec: Second, H. W: head wound, T. Ill: terminally ill.

Effect of sex and housing on the novel environment test of Nicholas white turkeys

The effect of sex on the novel environment on Nicholas white turkeys was assessed and presented in Table 6. The results show that latency to ambulate, latency to vocalize, number of vocalizations, number of steps/tiles, and number of defecations were not (P>0.05) affected by sex on both the male and female turkeys. However, escape attempts were significantly (P<0.05) affected by sex, with females having a higher frequency of escape attempts. This might be attributed to active defence, active avoidance, and it's the stimulation of the sympathetic nervous system that prepares the individual for fight, flight/escape attempt, or fright. In agreement with the present study, Fayeye *et al.* (2017) reported that the higher percentage of response among poults to escape attempt tests suggests a higher level of fearfulness and physiological activity in the turkey. According to Fayaye *et al.* (2017), more fearful animals have increased physiological responses to stressors compared to less fearful animals. Contrary to the result of the present study, Forkman *et al.* (2007) confirmed that birds that are inactive and silent experience greater fear than birds that move around the arena and vocalize. The novel environment test for poultry is intended to evaluate fear of novelty, activity coping ability and subjects' animals to social isolation (because animals are removed from their flock and tested individually) and is also used to assess social reinstatement motivation and welfare (Forkman *et al.,* 2007; Erasmus and Swanson, 2014). Therefore, Fayeye *et al.* (2017), De Haas *et al.* (2013) reported that fear is not only a negative affective state, but it is also associated with adverse effects on animal productivity and welfare, including increased injury, reduced production, and depressed growth.

The effect of housing in a novel environment on Nicholas white turkeys was assessed and presented in Table 6. The results show that there were no significant (P>0.05) differences across all the treatments. The results of Rasha *et al.* (2024) on turkey poults' performance, behavior, and welfare were under the present study. The authors reported that a significant difference was absent among floor and battery-reared turkeys in the percent of all behaviors performed and in the number of turkeys in the standing, ambulation, defecation, and escape behaviors. Also, the number of squares crossed didn't differ significantly between the two houses. However, there was a significant difference in order between the two housing systems in ambulation latency, vocalization number, and latency in the maze. The turkey poults reared in cages exhibited increased latency to ambulate and vocalize significantly than floor-reared poults. Moreover, the number of squares explored did not significantly decrease in caged poults, indicating fear in caged poults as reported by Rasha *et al.* (2024) from the findings of Jones (1989), and Durosaro *et al*. (2021).

Table 6: Effect of sex and housing on novel environment test of Nicholas white turkeys (number)

Parameters	Latency to amb.	Latency to voc.	No. of voc.	No. of Steps/Tiles	No. of defecation	Escape attempt	Lameness
Sex							
Male	16.00	94.67	16.83	5.17	0.33	0.17[b]	0.00
Female	29.50	176.00	64.00	1.67	1.17	2.00[a]	0.00
SEM	11.50	61.72	27.00	1.50	0.29	0.46	0.00
Housing							
Indoor	26.33	139.17	58.00	5.00	0.67	0.46	0.00
Outdoor	19.17	131.50	22.83	1.83	0.83	1.33	0.00
SEM	11.50	61.72	27.00	1.46	0.29	0.83	0.00
Interaction							
Sex * Housing	NS	NS	NS	NS	NS	NS	NS

[a-b] means that within rows bearing different superscripts differ significantly at $p > 0.05$; Latency to amb: latency to ambulate, Latency to voc: latency to vocalize, No. Of voc: number of vocalizations, No. Of Steps/Tiles: number of tiles/steps, No. Of defecation: number of defecations and SEM: standard error of mean.

Effect of range use on sex and time of Nicholas white turkeys

The effect of range use on the sex of Nicholas white turkeys was assessed and presented in Table 7. The results show that there were no significant differences (P>0.05) across all the treatments. This finding conforms with the finding of Hughes and Dun (1983) who maintained that no significant difference was found on the access to range by male and female birds and this was attributed to the fact that the ancestor of domesticated poultry, the red jungle fowl, was an inhabitant of the forest and lived in an environment that provided extensive shade and structure.

The effect of time on the range use of Nicholas white turkeys was assessed and were presented in Table 7. The results show that there were no significant differences (P>0.05) across all the treatments. Although, range area was not used optimally by all birds, Suleiman (2023). But the present study indicates non-significant differences among the treatments. Accessing poultry range utilization is very essential, and recent research on free-range chickens shows that individual behavioural differences may link to range use Rohlf *et al.*, 2019).

Table 7: Effect of range use on sex and time of Nicholas white turkeys

Variables	Range used
Sex	
Male	33.82
Female	30.10
SEM	3.90
Time	
Morning	26.91
Afternoon	37.01
SEM	3.90
Interactions	
Sex * housing	NS

[a-b] means that the rows bearing different superscripts differ significantly at $p > 0.05$; SEM: standard error of mean.

CONCLUSIONS AND RECOMMENDATIONS

It could be concluded that sex influenced growth performance. However, both sexes had similar FCR. The housing systems used in this study have no detrimental effect on the growth performance of turkeys reared under different housing systems. It could also be concluded that behavioural data obtained on sex revealed that there were significant differences between male and female turkeys in terms of pecking, walking difficulties, and aggressiveness. However, there were no significant differences in terms of human approach, novel object, transect walk, and novel environment tests. The effect of range use record revealed that sex and time on range use in this study had no significant differences across all the treatments evaluated. It could therefore be recommended that farmers be encouraged to adopt indoor and outdoor housing systems for their turkeys for the overall welfare and health status of their turkeys. Further research could be recommended to include environmental enrichment and stocking density in Nicholas White Turkeys to further investigate welfare parameters of turkeys, since there is scarce research on welfare indicators of Turkeys.

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REFERENCES

A Greener World (2023). Mortality in Poultry. *A Greener World Technical Advice Fact Sheet* No. 8. PCE11v3 – TAFS 8 - Mortality in Poultry 032111 ©.

AOAC. (2000). Official Methods of Analysis. *Association of Official Analytical Chemistry*, Washington, DC.

Appleby, M. C., Mench, J. A. & Hughes, B. O. (2004). Poultry *Behaviour and Welfare.* CAB International, Wallingford.

Baracho, Marta & Nääs, Irenilza & Bueno, Leda & Nascimento, Guilherme & Moura, Daniella. (2012). Broiler Walking Ability and Toe Asymmetry Under Harsh Rearing Conditions. Revista Brasileira de Ciência Avícola. 14. 217-222. 10.1590/S1516-635X2012000300009.

Bari, M.S.; Allen, S.S.; Mesken, J.; Cohen-Barnhouse, A.M. & Campbell, D.L.M. (2021). Relationship between Range Use and Fearfulness in Free-Range Hens from Different Rearing Enrichments. *Animals* 2021, 11, 300. https://doi.org/10.3390/ani11020300

Bartussek, H. (1999). A review of the animal needs index (ANI) for the assessment of animals' well-being in the housing systems for Austrian proprietary products and legislation. *Livestock Production Science* 61:179-192.

Buchholz, R. (1997). Male dominance and variation in fleshy head ornamentation in wild turkeys. *Journal of Avian Biology* 28:223-230.

Butterworth, A. (1999). Infectious components of broiler lameness: A review. Worlds. *Poultry Science Journal* 55, 327–352. doi:10.1079/WPS19990024

Dalton, H. A., B. J. Wood, & S. Torrey. (2013). Injurious pecking in domestic turkeys: development, causes, and potential solutions. *World's Poultry Science Journal* 69:865-876.

Dalton, H. A., B. J. Wood, T. M. Widowski, M. T. Guerin, & S. Torrey. (2018). Comparing the behavioural organization of head pecking, severe feather pecking, and gentle feather pecking in domestic turkeys. *Applied Animal Behaviour of Science* 204:66 71.

De Haas E. N, Kemp B, Bolhuis JE, Groothuis T. & Rodenburg TB. (2013). Fear, stress, and feather pecking in commercial white and brown laying hen parent–stock flocks and their relationships with production parameters. *Poultry Science* 92:2259–2269.

Durosaro, S.O., Iyasere, O.S., Oguntade, D.O., Ilori, B.M., Odubola, T.A., Adewunmi, A.P., Oyeniran, V.J. & Ozoje, M.O., (2021). Associations between plumage colour and fear behaviour in young Nigerian indigenous turkeys (Meleagris gallopavo). *Applied Animal Behaviour Science* 244, 105483.

Erasmus, M. & Swanson, J., (2014). Temperamental turkeys: Reliability of behavioural responses to four tests of fear. *Applied Animal Behaviour Science* 157, 100-108.

Erian, I. & C. J. C. Phillips. (2017). Public understanding and attitudes towards meat chicken production and relations to consumption. *Animals* 7:20.

European Food Safety Authority (EFSA) (2012). Scientific Opinion on the use of animal-based measures to assess the welfare of broilers. *Parma Italy*.

Ferrante, V., Watanabe, Susanna Lolli, Lorenzo Ferrari, Tatiane Terumi, Negrao Watanabe, Carlo TremolAgina, Joanna Marchewka & Inma Estevez (2019). Differences in prevalence of welfare indicators in male and female turkey flocks (*Meleagris gallopavo*), *Journal of Poultry Science* 0:1-7. https://dx.doi.org/10.3382/ps/pey534.

Forkman B., A. Boissy, M.C. Meunier-Salaün, E. Canali, R.B. Jones (2007). A critical review of fear tests used on cattle, pigs, sheep, poultry, and horses. *Physiological Behaviour*, 92 (3) (2007), pp. 340-374, 10.1016/j.physbeh.2007.03.016

Hughes BO, Dun P (1983). Production and behaviour of laying domestic fowls in outside pens. *Applied Animal Ethology* 11, 201

Jibia Z. S. (2021). Performance, haematological, serum biochemistry and welfare ethogram responses of Noiler birds. *MSc Dissertation*. Federal University Dutsin-Ma, Katsina State.

Jones, R.B. (1989). Avian open-field research and related effects of environmental novelty: An annotated bibliography, 1960–1988. *The Psychological Record* 39, 397-420.

Kamyab, A. (2001). Enlarged sternal bursa and focal ulcerative dermatitis in male turkeys. *World's Poultry Science Journal* 57:5 12.

Krautwald-Junghanns, M. E., R. Ellerich, H. Mitterer-Istyagin, M. Ludewig, K. Fehlhaber, E. Schuster, J. Berk, S. Petermann, & T. Bartels. (2011). Examinations on the prevalence of footpad lesions and breast skin lesions in British United Turkeys Big 6 fattening turkeys in Germany. Part I: Prevalence of footpad lesions. *Poultry Science* 90:555-560.

Kulke, K., Kemper, N. & Stracke J. (2021). Boys (toms) don't try. Behaviour of turkeys in a Novel Object test – Influence of age and sex.

Lendvai Ádám Z., Veronika Bókony & Olivier Chaste (2010). Coping with novelty and stress in free-living house sparrows. *The Journal of Experimental Biology* 214, 821-828

Marchewka J., Watanabe T. T. N., Ferrante V. & Estevez I. (2013b). Review of the social and environmental factors affecting the behaviour and welfare of turkeys (*Meleagris gallopavo*). *Poultry Science* 92:1467-1473.

Marchewka J., Watanabe T.T. N., Ferrante V. & Estevez I. (2024). Welfare assessment in broiler farms: Transect walks vs. individual scoring, *Animal welfare indicators* (AWIN)

Marchewka Joanna, Guro Vasdal & Randi O. Moe (2020). Associations between on-farm welfare measures and slaughterhouse data in commercial flocks of turkey hens (*Meleagris gallopavo*), *Poultry Science* https://doi.org/10.1016/j.psj.2020.05.036

Marchewka, J., Estevez, I., Vezzoli, G., Ferrante V. & Makagon M. (2015). The transect method: a novel approach to on-farm welfare assessment of commercial turkeys. *Poultry Science* 94:7 16.

Marchewka, J., G. Vasdal, & R. O. Moe (2019). Identifying welfare issues in turkey hen and tom flocks applying the transect walk method. *Poultry Science* 98:3391-3399.

Marsden, S. J. & M. Holmes (2016). Turkey Management: *A Comprehensive Guide to Raising Turkeys*. Norton Creek Classics. Blodgett, OR: Norton Creek Press, 2016.Fayeye Timothy Rotimi, Foluke Eunice Sola-Ojo, Adeola Racheal ObAginare & Kolade Luke Ayorinde (2017). Behavioral Responses to Open Field Tests in Nigerian Local and Nicholas White Turkeys

Mitterer-Istyagin, H., M. Ludewig, T. Bartels, M. E. Krautwald Junghanns, E. Ellerich, E. Schuster, J. Berk, S. Petermann & K. Fehlhaber (2011). Examinations on the prevalence of footpad lesions and breast skin lesions in B.U.T. Big 6 fattening turkeys in Germany. Part II: Prevalence of breast skin lesions (breast buttons and breast blisters). *Poultry Science* 90: 775–780.

Moinard, C., P. D. Lewis, G. C. Perry & C. M. Sherwin (2001). The effects of light intensity and light source on injuries due to pecking of male domestic turkeys (*Meleagris gallopavo*). *Animal Welfare* 10:131–139

Muri, Karianne, Solveig Marie Stubsjøen, Guro Vasdal, Randi Oppermann Moe & Erik Georg Granquist (2023). Associations between qualitative behaviour assessments and measures of leg health, fear and mortality in Norwegian broiler chicken flocks, *Norwegian University of Life Sciences, Faculty of Veterinary Medicine*

Newberry, R.C. (1995). Environmental enrichment: increasing the biological relevance of captive environments. *Applied Animal Behaviour Science,* 44(2-4), 229-243

Nigeria Meteorological Agency (2024). DTM, Seasonal Climate Prediction (SCP), *Nimet,* 2024

Odutayo OJ. Sogunle OM. Akinosi OK. Safiyu KK. & Ekunseitan DA. (2015). Effect of varying litter depths on growth performance and linear body measurements of locally adapted turkey poults, *Proceedings of the 20th Annual Conference of Animal Science Association of Nigeria* (ASAN) *co-organized with Nigerian Institute of Animal Science* (NIAS), pp. 525-527.

Olajide Mark Sogunle, Muideen Aderemi Ogundele, Olufemi Sunday Akinola, Chiemeka Promise Njoku & Abimbola Oludele Oso (2015). Effects of different housing systems on growth performance and carcass yield of two breeds of turkey. *Bulletin Animal Health Production Africa*, 63, 209 – 219

Oyeagu Chika Ethelbert, Iwuchukwu Juliana Chinasa, Falowo Andrew Bamidele, Akuru Eunice Amaka, Adetunji Adewole Tomiwa, Lewu Francis Bayo, Yiseyon Sunday Hosue, & Idamokoro Emrobowansan Mondaye (2022). Assessment of turkey farming management practices by small-scale rural farmers in eastern Nigeria. *Asian Journal of Agriculture and Rural Development* Volume 12, Issue 1 (2022): 30-39.

Rabie, M. H., El. Sherif, Kh, Abd El-khalek, A. M. & El-Gamal, A.A.A. (2017). Effect of Dietary Energy and Protein on Growth Performance and Carcass Traits of Mamourah Cockerels. *Asian Journal of Animal and Veterinary Advances.* 12: 142-151.

Rasha R. Ibrahim, Naglaa M. Abdel Azeem, Hosny Emeash & Asmaa K. Abdelghany (2024). Performance, behaviour, and welfare of turkey poults reared under different housing conditions. *Journal of Advanced Veterinary Research* (2024) Volume 14, Issue 1, 30-36

Schrider, D. (2013). *Storey's Guide to Raising Turkeys: Breeds, Care, Marketing*. *3rd ed. North* Adams, MA: Storey Publishing, 2013.

Schütz, K. E., Kerje, S., Jacobsson, L., Forkman, B., Carlborg, Ö., Andersson, L. & Jensen, P. (2004). Major growth QTLs in fowl are related to fearful behavior: possible genetic links between fear responses and production traits in a Red Jungle fowl × White Leghorn intercross. *Behavioural Genetics*, 34: 121-130.Rohlf, V.I., Howell, T.D., Coleman, G. & Rault, J.L. (2019). Engagement through online discussion: Perceptions on laying hen welfare in furnished cages. *Animals,* 13:1999-2006

Special Eurobarometer (2016). "EU Citizens' views on development, cooperation and aid". *Report Linguistic version* EN. Catalogue number MN-01-17-178-EN-N. ISBN 978-92-79-66608-7. doi:10.2841/802662.

Statistical Analysis System (2007). Statistical User Guide. *SAS Institute Inc*., Cary, NC, USA

Suleiman A., Sabo M. N. & Maryam A. I. (2024). Welfare and performance evaluation of Noiler chickens reared under different housing types. *Agricultural Science: An International Journal* (AGRIJ), Vol . 1, No.2, 2024

Suleiman, Aliyu. (2023). Performance and Welfare Parameters of Noiler Chickens Reared Under Different Housing Types. *Project.* Department of Animal Science, Faculty of Agriculture, Federal University Dutsin-Ma, Katsina State.

Tong, H. B., Wang, Q., Lu, J., Zou, J. M., Chang, L. L. & Fu, S. Y. (2014). Effect of free-range days on a local chicken breed: Growth performance, carcass yield, meat quality, and lymphoid organ index. *Poultry Science* 93: 1883-1889. https://dx.doi.org/10.3382/ps.2013-03470.

Zhao Zi-guang, Jian-hong Li, Xiang Li, & Jun Bao (2014). Effects of Housing Systems on Behaviour, Performance and Welfare of Fast-growing Broilers. *Asian Australians Journal of Animal Science* http://dx.doi.org/10.5713/ajas.2013.13167

Zhou ZL., Rath NC., Huff GR., Huff WE., Rasaputra KS., Salas C. & Coon CN. (2011). Bone Characteristics of 16 Turkeys Subjected to Different Dietary Supplements and Simulated Stress. *International Journal of Poultry Science*, 10(5): 332-337.