DETERMINATION OF MOST SUITABLE METHODOLOGY FOR MEASURING DOCILITY IN GUINEA FOWLS (*Numida meleagris*) IN GHANA

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https://dx.doi.org/10.4314/gjansci.v14i1.8

ABSTRACT
The aim of this research was to study the effect and most suitable methodology in measuring docility of Guinea fowls in Ghana. The study was carried out at the Poultry Section of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti campus in Ghana. Docility was measured on a 4-point scale as docile (1), flighty (2), restless (3) and aggressive (4). Seventy-nine (79) Guinea fowls of local varieties of average age 10 months were consecutively tested for docility twice a week for four weeks. The birds were tested for behavioural docility in a Completely Randomised Design experiment. Data were analysed using SAS and separation of means was done using LSD. The research revealed that the test criterion had significant ($p<0.05$) effect on docility. Based on this observation, each individual criterion was unique and can be used independently for the assessment of docility status of the birds. The Human Presence Test (HPT), Novel Object Test (NOT), Contact Test (CT), and Handling Test (HT) produced consistent docility. The HPT, NOT and CT were similar in effect. The method that produced the greatest impact on the birds was HT and hence not suitable for assessing docility of birds. If the test methods are to be used individually, HPT, NOT and CT will be ideal. The most suitable pair of methods that assesses the underlying docility trait very effectively was HPT with NOT and is therefore recommended as the best suitable pair for cage docility scoring. The research revealed that the test criterion of docility (method of assessment) has to be chosen carefully to be used to assess or measure docility of birds.

Keywords: *Docility, Temperament, Human Presence Test (HPT), Novel Object Test (NOT), Contact Test (CT), and Handling Test (HT).*

INTRODUCTION
In poultry production, movement and handling of the birds is inevitable. Guinea fowls especially have the behaviour of climbing and sleeping on trees under extensive system of rearing. Besides, guinea fowls have some behavioural problem that has to do with poor temperament/ docility. This behaviour could have some relationship with their poor docility character. The genetic characteristics of this important trait has been established in grasscutter (Annor *et al.,* 2011), using solely an observation method based on four-point scoring system.

Historically, the techniques for measuring docility have long been established but are continually

being refined and improved making it possible to accurately measure docility. Its measurement has been based on objective or subjective analogue scales systems of scoring. Docility test experiments include, flight speed test (exit velocity), pen scores, and chute scores used on non -avian species. These methods vary in their robustness in assessing the animal of its temperament and so new measurements began to appear including the heterophils to lymphocytes (H/L ratios) and the behavioural test (cage scoring) for the avian species (Fordyce *et al*., 1982).

Earlier scientists such as Cooke and Bohner (2010) agreed that new methods have been developed and used for evaluating docility and these ranges from simple visual observations to assessments that require computerized techniques. These methods can be divided into restrained techniques, non-restrained techniques, and phenotypic evaluations. The restrained techniques evaluate temperament when animals are physically restricted, such as in, the squeeze chute (chute scoring) while the non-restrained techniques evaluate animal docility based on their fear or aggressive response to humans when they are free to move within the evaluation area (flight speed and exit velocity). Authors such as King *et al*. (2006) and Annor *et al.* (2011) already used cage scoring to evaluate the animals' responses to human approach in a cage on a categorical scale.

The behavioural docility test methods were developed for especially cattle and sheep (Tulloh, 1961; Hearnshaw *et al*., 1979; Grandin, 1993).

There are various forms of these subjective assessments on various livestock but none has been developed for that of the guinea fowl. Moreover, this aspect of animal research is often overlooked especially in developing countries like Ghana.

On the bases of this that this study was conducted to determine the most suitable test methodology in measuring docility of guinea fowls using categorical scoring systems that quantifies the response to confinement in cages.

MATERIALS AND METHODS

The study was conducted at the Guinea fowl Section of the Department of Animal Science Education, University of Education Winneba, Mampong-Ashanti campus, Ghana. The study lasted for three months. Mampong-Ashanti lies in the transitional zone between the Guinea savanna zone of the north and the tropical rain forest in the south of Ghana (Ghana Districts, 2006).

Geographically, Mampong-Ashanti lies between longitude 00 05 west and 10 30 west and latitudes 60 55 north and 07 30 north and with an altitude of 457 m above sea level. Rainfall in the district is bimodal, occurring from April to July (major rainy season) and August to November (minor rainy season), with an average rainfall of about 1224 mm per annum. The dry season occurs from December to March (Ghana Meteorological Service, 2010). The vegetation in this area is transitional savanna woodland, which is suitable for livestock rearing due to prevailing conducive rearing temperatures.

Management of Experimental Birds

The experimental birds used were Lavender, Pearl and White Guinea fowls. Females and males genetic lines of guinea fowls were selected at 8 weeks of age. A total of 79 birds comprising of 48 females and 31 males of the local guinea fowls were used.

The birds were obtained as day-old keets from a local commercial hatchery (Akate Farms Ltd) in the Ashanti Region of Ghana and raised to 10 months of age for the experiment. All the birds were housed in three-tier wooden cages with each bird housed singly in a cage of size 60 cm x 50 cm x 40 cm. The cages were partitioned with wire mesh. The sides and floor of the wooden cages were also covered with wire mesh. Boards of packing cases were used to bar the birds within a single three-unit tier from seeing each other. In order to ensure that birds in adjacent tiers do not see birds in other tiers, the tiers were sealed at the rear and back with packing cases. The down and middle tiers were decked with wood and lined with floor carpet to enable collection of droplets of birds and liquid from the top-tiers and also to aid in cleaning and drainage of liquid from stacks above. Cages were housed in a sandcrete house roofed with corrugated iron sheets. The birds were identified using cage numbers plus sex and breed notations.

The birds were vaccinated at 10 days of age against Infectious Bursal Disease via their drinking water. At 4 weeks of age, the keets were also vaccinated against Newcastle Disease and Infectious Bronchitis through the same route. All birds were vaccinated against second and third Newcastle Disease. Birds were de-wormed with Albendazole, 2.5% (Mobedco-Vet, Jordan), two weeks prior to the experiment.

The keets were fed starter mash containing 2,950 kcal ME/kg and 21% crude protein from 10 to 20 days of age. From 21 days of age the diets were changed to a grower diet containing 3,200 kcal ME/kg and 19% crude protein followed by a layer diet containing 3,100 kcal ME/kg and 19% crude protein during the experiment.

On each day, the birds were fed in the morning at about 8:00 hours GMT, the behavioural docility tests were carried out before feeding the animals in the morning by two evaluators.

Feed and water were provided in empty tinned tomato containers. Feed intake was measured daily, where the left-over feed was weighed using a 3000 g capacity Electronic Kitchen Scale and subtracted from the total amount of feed offered the previous day to get the daily feed intake.

Only one death was recorded during the experiment and postmortem examination revealed broken egg within the *infandibulum* which might have occurred during the transfer of the birds into the individual cages.

Experimental design

Docility was defined as *the ability of the bird to be calm in human presence, novel object, human contact/touching and handling* and scored on a scale of 1 to 4 (Annor *et al.,* 2011) as shown in Table 1. The duration of the docility scoring experiment lasted for 4 weeks. There were four tests/treatments applied to each bird irrespective of the sex, variety and initial weight.

The docility test was systematically carried out twice every week over a period of four weeks.

To distinguish and classify the birds in terms of the test definition (temperament of the birds), the birds in the cages were systematically exposed to the Novel Object Test (NOT), Human Presence Test (HPT), Handling Test (HT) and Touch or Contact Test (CT) (Table 1) by two evaluators, one test after another at short time intervals.

Data collection

During the evaluations, each bird's docility status (DS) was assessed by two evaluators using simple visual appraisal and the average score taken on each bird.

At the point of assessment, each bird was assigned a subjective docility score (DS) (detailed in Table 2) by the two evaluators based on a 4-point scale defined by Annor *et al.* (2011) with some modifications. The score was based on several behavioural component measures that indexed how much resistance Guinea fowl showed during behavioural test (see Table 2 for more details), and was assessed by the same experienced evaluators at each behavioural test.

Table 1: Description of the tests methods used to assess the temperament of the Guinea fowls

Test	Description	Test Objective
Human presence/Moving person Test (HPT)	Person walks up to the cage;	To ascertain the bird's reaction to a moving person and/ or human presence.
Touch/Contact Test (CT)	Person try to make a physical contact with the bird	To test the capability of the bird to accept person making contact or touching
Novel Object Test (NOT)	Person throw a novel object in the cage of the bird	To test the ability of the bird to react to an unknown (novel) object
Handling Test (HT)	Person physically handles the bird for 5 seconds	To test the ability of the bird to accept handling

The DS for each point in time was averaged between the two evaluators. The average docility score for the whole period amounted to 8 individual tests on each bird. The average docility score from the eight (8) individual tests on each animal was then used in the analysis.

Two weeks' preliminary observations were carried out on the birds in order to ascertain whether there was the need to modify the assessment criteria adopted by Annor *et al.* (2011). It was concluded that, one requires a set of descriptive factors to categorise the birds' behaviour into docile, restless, flighty and aggressiveness.

Data Analysis

The MS Excel (2007) was used to summarize and organize the data for analysis with SAS (2008) software. The effects of test methods on docility scores were analyzed using Generalized Linear Mixed Models (GLMM) with GLIMMIX procedure of SAS (2008). The model used for the analysis was:

$$Y_{ij} = \mu + M_j + \varepsilon_{ij} \quad (1)$$

Definitions of variables in this model were:

Y_{ij} = observations (docility status) of bird;
μ = General mean (population mean);
M_j = Effect of k^{th} test method on docility;
j = 1, 2, 3 and 4; (1 = Human present test,
2 = Contact test, 3 = Novel object test,
4 = handling test)
ε_{ij} = residual effect

The level of suitability of the pairs of test methods was measured by the correlational relationship between any pair of behavioural traits. The stronger the correlational relationship by indication of its correlational coefficient the better the suitability measure.

RESULTS AND DISCUSSION

Docility scores due to the methods had similar patterns within and across the methods (Table 3). For instance, there was a consistent significant

Table 2: Docility scoring codes and descriptions representing the behavioural traits of the bird

Scale/ Score	Code	Test	Reactions (behaviour) of Bird
1	*Docile* (the bird is quiet, compliant, submissive, obedient, tame)	HPT	The bird does not react to observer. Allow observer to approach. The bird maintains its proximity
		NOT	Bird is quiet, calm and moves away slowly
		CT	Undisturbed and stands or moves slowly
		HT	Allow to be picked up and handled easily
2	*Flighty* (the bird is changeable, undependable, inconsistent, unreliable)	HPT	Aware of an observer, the bird stands away from the observer in a corner
		NOT	The bird runs/moves away from the object
		CT	Constant and moderate movements
		HT	Tries to escape. Struggles little and stop
3	*Restless* (the bird is impatient, agitated, unrelaxed)	HPT	Frighten and moves away on sighting an observer and persistently looking for escape holes along the cage. The bird hardly stands at one point.
		NOT	The bird runs/moves away from the object, continuously moving in the cage during the time of assessment
		CT	The bird jumps and makes sharp cry(s)
		HT	Whiles in hand, struggles and wing flapping
4	*Aggressive* (violent, hostile, destructive)	HPT	The bird begins to move vigorously and continuously along cage and attempts to escape and sometimes with sharp cry
		NOT	Bird jumps and raises its feet off the cage floor and making persistent cries
		CT	Difficult touching the bird
		HT	Whiles in hand, continuously struggles throughout

HPT – Human Presence Test, NOT – Novel Object Test, CT – Contact/Touch Test, HT – Handling Test.

Table 3: Least Square Means and Standard Errors for the Effects of Method on Docility scores

Variable	No.	Weekly Docility Score				
		Week 1	Week 2	Week 3	Week 4	Average Docility
Method						
HPT	79	1.90±0.055^{c}	1.49±0.050^{b}	1.24±0.045^{c}	1.23±0.04^{c}	1.47±0.034^{d}
NOT	79	2.44±0.055^{b}	2.22±0.050^{a}	1.95±0.045^{b}	1.92±0.042^{b}	2.14±0.034^{c}
CT	79	2.64±0.055^{b}	2.42±0.050^{a}	2.12±0.045^{b}	2.11±0.042^{b}	2.33±0.034^{b}
HT	79	3.11±0.055^{a}	2.49±0.050^{a}	2.39±0.045^{a}	2.33±0.042^{a}	2.58±0.034^{a}
Mean Doc.		**2.52±0.055**	**2.16±0.050**	**1.93±0.045**	**1.89±0.042**	**2.13±0.034**
P Value		*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*
St Dev.		*0.62*	*0.56*	*0.56*	*0.53*	*0.49*

No. = number, St Dev. = Standard deviation, P Value = Probability Value, HPT = Human Presence Test, NOT = Novel Object Test, CT = Contact Test, HT = Handling Test; Doc = Docility
NB: Means between/among weeks with different superscripts are significantly different (p<0.05).

increasing trend in the docility scores for each method across the weeks up to the third week. From the third week onwards, there were decreasing trends in docility scores within all the methods (i.e. across the weeks). The visible trend is that, from the third to the fourth week of assessment, the docility scores recorded remained relatively constant (Table 3) within each method (i.e. across the weeks).

The method used in determining docility of the birds significantly influenced the behaviour and response of the birds. Since a significant effect was found between the test method and docility ($p< 0.001$), it means in the assessment of docility trait, the test methodology is very important as a non-genetic factor.

The individual methods were also found effective in determining the docility status of the birds because each of them had a significant ($P< 0.001$) effect on the weekly docility scores. The significant differences were observed between the individual docility scores for all the methods from week one to week three signified the effectiveness of each method and that was confirmed by the average docility scores for all the methods (i.e. 1.47±0.034, 2.14±0.34, 2.33±0.034 and 2.58±0.034 respectively for HPT, NOT, CT and HT). However, the use of HT showed that the birds were rather somehow restless (2.58≈3) in nature whiles the others (i.e. NOT and CT) indicated that the birds were flighty. Also, HPT average docility score (1.47) indicated that the birds were either docile or flighty in nature. These differences indicate how the birds perceived the various methods. Some of the methods could have been very much stressful and caused a lot of fear and anxiety in the birds.

The birds showed restlessness with the use of HT which agrees with the reports by Fordyce *et al.* (1988); Grandin (1997); Curley Jr *et al.* (2006a); and Burrow and Dillon (1997), who stated that during handling, fear is a major determinant of an animal's behaviour and the degree of the effects of handling felt by animals depends on the temperament of the animal. Grandin (1997) specifically proposed that, handling might be more stressful to temperamental animals than to those animals that are calmer.

Despite this, there were some similarities and dissimilarities between the methods in terms of their effect on docility. Those that were resilient in effect (i.e. those that show consistency in docility score) throughout in this research are adjudged reliable (i.e. HPT, NOT and CT). The HT produced rather wider inconsistent results of docility score differences in successive times.

The NOT and CT were similar in effect on docility since there were no significant differences (P> 0.001) between their respective docility scores.

The decreasing pattern in docility scores for each of the methods, HPT (1.9 – 1.2), NOT (2.4 – 1.9), CT (2.6 – 2.1), and HT (3.1 – 2.3) from week 1 to week 4 corroborates the findings of Hearnshaw and Morris (1984), Grandin (1993), Burrow and Dillon (1997), Gibbons *et al*. (2009) and Turner *et al*. (2011) which states that, animals' response to each of these measures of temperament is repeatable overtime despite the method use.

The Most Suitable Test Methodology in Measuring Docility

Consistency of the Test Methodology

The first criterion employed to establish the most suitable measures of docility was based on finding the test methodology that was consistent in producing results that were repeatable since research showed that docility character of an animal was repeatable irrespective of the method used or circumstance (Hearnshaw and Morris, 1984; Grandin, 1993; Burrow and Dillon, 1997; Gibbons *et al.,* 2009; Turner *et al.,* 2011). From Table 3, it was observed that all the methods HPT, NOT, CT and HT produced docility scores across the weeks in a pattern of decreasing order that was consistent throughout the experiment. All the methods used performed exceptionally well in producing consistent significant differences between the weeks' docility scores from the start of the experiment up to the third week.

Those that produced repeated minimal score differences at different times (across the weeks) or situations were seen with NOT, CT and HPT methods and their average docility score differences was 0.2 score points while that of HT was 0.3.

In the NOT and CT, a docility score difference of 0.2, 0.3, 0.0 were produced respectively for week one and two, week two and three and three and four. On the other hand, the use of the HPT method produced docility score differences of 0.4, 0.3 and 0.0 respectively for every two successive weeks. Finally, the HT also produced docility score differences of 0.6, 0.1 and 0.1 respectively for every two successive weeks. The above figures indicated HPT, NOT and CT as being consistent and similar in effect.

Use of test method to assess correlation between Docility and Behavioural Measures of Docility

Another strategy was to measure the strength of the method in assessing the underlying trait. The correlations of docility with each of the methods were conducted and these are shown in Table 4.

Table 4: Strength of relationship between behavioural measures and docility scores

Method	Mean	Standard deviation	Docility	P-value
Handling Test	2.61	0.16	0.672**	0.000
Human Presence Test	1.50	0.28	0.619**	0.000
Novel Object Test	2.16	0.24	0.569**	0.000
Contact Test	2.33	0.24	0.425**	0.000

** = *Correlation is significant at the 0.01 level (2-tailed)*

Among the four methods, the one that produces the greatest impact on the bird was one with highest correlation coefficient with docility. In terms of the method that produced the greatest effect on docility of the birds, the order is from the handling test to contact as showed in Table 4.

From the above deduction, handling test seemed to have the greatest effect on docility score of the birds. Despite this, it also provided wider docility score difference between the first week and the second week signifying the greater effect it leaves on the birds and how that method was perceived by the birds. The human presence test, the novel object test and the contact test on the other hand were very much similar in effect; they showed resilience in producing consistent docility scores throughout the experiment. The consistency of producing repeated minimal score differences between any two successive times or situations judges the reliability of the method used. In terms of reliability therefore, the HPT, NOT and CT can be counted on. Most importantly, they each produced significant effect in assessing the underlying trait since they each yielded above average correlation coefficient.

Assessing the Underlying Trait

The most suitable test methodology in this study was taken to be one which actually assesses the underlying trait (docility). In order to ascertain this, the various tests were correlated with each other to yield a pair of tests which recorded the highest correlation coefficient. The result in Table 5 shows the relationship among the behavioural docility measures. According to Grandin (1993) for the sake of accuracy, it is appropriate to adopt multiple methods to assess behavioural docility. However, it is of interest to understand whether these different tests measure the same underlying trait through correlation analysis. On the overall, this would suggest that these tests are assessing similar if not identical underlying traits (Burdick *et al.,* 2011).

A number of studies have found a significant relationship among the measures. For example, Fell *et al*. (1999); Olmos and Turner (2008); Hoppe *et al*. (2010) and Café *et al*. (2011) recorded a significantly moderately correlated result for flight speed and chute test score beef cattle. A similar strategy was adopted here in this study, by finding the strength of the relationship that existed between the measures to represent the level of suitability of the pair in assessing the behavioural docility of the birds. They were arranged in order of importance from highly suitable to the least suitable. The results show that the human present test with the novel object test was the most suitable among the six available pairs. Some researchers such as Turner *et al*. (2011) also found positive relationship between chute score and flight speed methods, though slightly different from those used here. The least suitable was using contact test alongside the human presence test.

The contact test use with the human presence test from the analysis would yield negative results (effect) whenever used together in assessing the behavioural docility.

The other pairs such as Human presence – Novel Object test, Contact test – Handling test, Human Presence – Handling test, Novel Object – Handling test, and Novel Object – Contact test produced positive relationships which were in agreement with the findings of other researchers like Curley Jr *et al*. (2006b) who found a moderate relationship between chute scores and response to confinement in a pen. However, there have been mixed reports concerning these relationships since others have reported weaker correlations. An example of those who reported weak relationship was the Burrow and Corbet (2000).

Table 5: Correlational relationships among the behavioural measures

Pair of test method	Level of suitability
Human presence – Novel Object test	0.409**
Contact test – Handling test	0.177
Human Presence – Handling test	0.148
Novel Object – Handling test	0.043
Novel Object – Contact test	0.058
Human Presence – Contact test	- 0.052

** = *Correlation is significant at the 0.01 level (2-tailed)*

CONCLUSIONS

The methods, human presence test (HPT), novel object test (NOT) and Contact test (CT) produced consistent docility scores and are similar in effect. The NOT and HPT used together in assessing the underlying docility trait of the birds have proven efficient and reliable to accurately measure docility. The method that produced the greatest impact on the birds was Handling test (HT). The research revealed that the test criterion of docility (method of assessment/ measurement) has to be chosen carefully to be used to assess or measure docility of birds.

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