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# The effects of crude oil contaminated feeds on the yield and quality of eggs of poultry birds (*Gallus domesticus*)

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**Abstract**
The effects of the ingestion of oil-contaminated feeds an egg production of poultry birds (*Gallus domesticus)* were investigated. The results indicated that those birds which ingested the treated feeds laid means of 5.0, 2.7 and 1.9 eggs for the 0.75m1/300g, 15m1/300g and 3.0ml/300g treatment levels, while the control laid 8.0 eggs per ten (10) birds per day. The weights of the eggs of the control (52.19+1.73g) were significantly higher than the treated cases, which were 56.29g; 61.83; and 64.57g for treatments 1, 2 and 3 respectively ($P \leq 0.05$). The mean albumen height also varied significantly with 6.06cm for the control and 5.49, 5.68 and 5.30cm for T1, T2 and T3 respectively. Also the Haugh Unit ranged from 83.96 for the control to 71.52, 70.01 and 69.01 for T1, T2 and T3 respectively. The egg shell thickness for the control (0.34cm) was significantly higher than the treatment values of 0.23cm, 0.20cm and 0.19cm for T1, T2 and T3, yolk index analysis showed significantly higher value for the control 1.18 compared to 1.0, 0.99 and 1.0 for T1, T2 and T3. These effects would collectively affect the quality of the egg, survival of the embryo and their hatchability. It would also increase the chances of egg spoilage and reduce their market value. The speedy clean up of oil polluted areas is suggested as a means of reducing the overall impact an birds.

## 1 Introduction

The exploration and exploitation of crude oil plays a major role in Nigeria economy, but leaves behind the less attractive consequences of the oil industry activities: oil pollution. Potential sources and causes of oil pollution in oil industry operational areas in Nigeria include; blowouts, equipment failure, operational/maintenance errors, engineering failures, natural causes, third party, sabotage, sand cut accidents and other unknown causes (IFEADI AND NWANKWO, 1987). Other sources may be as a result of transportation and marketing and spillages that occur at ports and terminals (DUDLEY, 1976). The effects of crude oil and its products an organisms are diverse, but generally, severe toxic effects are known to be associated with low boiling point compounds and aromatics (EKWEOZOR, 1989). Heavy oils such as bunker C fuel oil or diesel oil may blanket areas of the shore and kill organisms through smothering. The effect of oil spillage an aquatic

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birds is one of the most striking compared to other recorded effect. For example about 30,000 birds died following the Torrey Canyon spillage (Bourne *et al.,* 1967). Between 1967 and 1971 about 250,000 seabirds mortalities were recorded worldwide as a direct effect of oil spillage (Clark, 1973).

It was suggested that the reasons why birds constitute the most frequent and largest casualties is related to their presence in heavily trafficked sea lanes, their large numbers, high proportion of time spent an the water to feed, as they are covered in the process with oil when they break the surface in an oil stick. Such heavily oiled and water soaked birds frequently stop feeding and go ashore, where they are isolated from their food supply. Many never make it to the shore but drown in the open sea because of loss of buoyancy. Birds may be affected directly through oiling of the feathers, exposure of eggs to oiled feather and by ingestion of oil contaminated foods. They may also be affected indirectly through changes in habitat and food supply and by exposure to oil through the food chain. Oil ingestion had been implicated in the high mortality of seabirds as this was noted to cause lipid pneumonia, gastro-intestinal irritation, fatty liver and enlargement of the adrenal gland (Hartung and Hunt, 1966). Oil ingestion has also been shown to affect the reproductive capacity of birds. Hartung (1965) showed that ducks fed with diets containing oil laid significantly less number of eggs than the control, but its effect an egg quality has not been analysed.

With the number of spillages occurring in the aquatic and terrestrial environments in the oil producing areas of Nigeria, it has become necessary to assess the effect of the ingestion of oil-containing diets an the reproductive potentials of domesticated birds, the quality of eggs laid and chances of their hatchability being affected as these birds and the wild ones often feed within polluted environment.

## 2 Materials and Methods

Thirty layer poultry (Gallus domesticus) were obtained from the River State School to Land Poultry Farm and put into 3-room partition cage. They were assigned into three groups of 10 for each of the Groups I, II and III respectively. Nigerian light crude oil (obtained from Shell Petroleum Development Company of Nigeria, East) was mixed in 0.75ml, 1.5ml and 3.0ml each with 300g of commercial "Sanders" layer feed. This served as the treatment substrate. The birds were fed with the feed without the oil treatment for the first 10 days and then given the oil contaminated feeds for the next 10 days.

All the eggs laid within the period were collected, labelled and stored in the fridge according to each group until analysed within 14 days of the study.

### 2.1 Egg quality analysis

Egg Weight: The weight of each egg was measured with the Mettler balance to the nearest 0.01 g.

## 2.2 Haugh Units

Randomly selected eggs from each group were boiled and allowed to cool. The egg was broken into two halves an a white tile and the albumen height was measured using Veneer callipers to the nearest 0.01 cm. The Haugh unit of egg was calculated as:

$HU = 100 \log (H - 1.7 W 0.37 + 7.57)$

where:

HU : Condition of thick albumen in Haugh Units
H : Height of thick albumen in cm
W : Weight of egg in g.

## 2.3 Yolk Index

The yolk height of the broken eggs was measured directly (without removing it from the albumen) using the Veneer callipers and recorded to the nearest 0.01 cm. Also, the yolk diameter was measured using the same instrument. The yolk index was calculated as the ratio of the yolk height to the diameter.

$$\text{Yolk Index} = \frac{\text{Height of Yolk (cm)}}{\text{Diameter of Yolk (cm)}}$$

## 2.4 Shell Thickness

The shell of the broken egg was further broken into several pieces and the membrane removed manually. The thickness of 5 pieces of each eggshell was measured using a micrometer screw gauge. The shell thickness was the mean of the 5 measurements expressed in millimetres (mm)

# 3 Results and discussion

## 3.1 Effects on Egg Productivity:

The analysis of the effect of ingestion of oil particles an egg production is shown in Table 1. Compared to average of 7 - 8 eggs laid per 10 birds per day used as control, those that ingested food items mixed with 0.75m1 of oil laid a mean of 5.07 eggs per day whilst those in treatment groups 2 and 3 with 1.5m1 and 3.0ml of oil treatment laid means of 2.67 and 1.93 eggs respectively over the period.

These differences when compared statistically (t-test at 95% confidence limit) were shown to be highly significant, (t = 11.6567, 17.1515 and 19.502 for treatments 1, 2 and 3 respectively).

This showed that the ingestion of oil even at the lowest level (0.75m1/300g of feed) used in this experiment significantly affected egg production by the birds. Earlier work by HARTUNG (1965) indicated that Mallard and Pekin ducks fed with 2m1/kg body weight of relatively non-toxic lubricating oil stopped laying eggs for 2 weeks. The findings of this study indicate that the *Gallus domesticus* fed with 3.0ml/300g of the test feed stopped laying eggs after 10 days. The implication of this particularly in oil producing communities of the Niger Delta area of Nigeria would be that domestic birds that feed within these oil polluted areas are likely to ingest more than 2ml/kg of body weight considering the levels of oil recorded in the sediments of such areas. The Impact of which will be a highly significant reduction in egg production of such birds.

**Table 1:** Mean Number of Eggs laid before and during treatment.

| Duration of Experiment | Pre-treatment | | | Treatment Period | | |
|---|---|---|---|---|---|---|
| Days | Cage 1 | Cage 2 | Cage 3 | Cage 1 (0.75ml) | Cage 2 (0.5ml) | Cage 3 (3.0ml) |
| 1 | 8 | 9 | 8 | 8 | 7 | 6 |
| 2 | 8 | 9 | 7 | 7 | 5 | 4 |
| 3 | 9 | 8 | 8 | 7 | 4 | 3 |
| 4 | 7 | 8 | 8 | 6 | 4 | 3 |
| 5 | 8 | 7 | 8 | 5 | 3 | 2 |
| 6 | 8 | 8 | 9 | 6 | 5 | 2 |
| 7 | 9 | 7 | 8 | 4 | 3 | 2 |
| 8 | 8 | 8 | 8 | 4 | 2 | 3 |
| 9 | 9 | 7 | 9 | 3 | 2 | 2 |
| 10 | 9 | 8 | 8 | 4 | 2 | 2 |
| 11 | 7 | 8 | 8 | 3 | 2 | 0 |
| 12 | 8 | 7 | 8 | 3 | 1 | 0 |
| 13 | 8 | 8 | 7 | 2 | 0 | 0 |
| 14 | 8 | 7 | 9 | 2 | 0 | 0 |
| 15 | 7 | 9 | 9 | 2 | 0 | 0 |
| $\bar{x}$ | 8.07 ± 0.18 | 7.87 ± 0.19 | 8.13 ± 0.17 | 5.07 ± 0.52 | 2.67 ± 0.53 | 1.93 ± 0.45 |

t-test values: T1=11.6567; T2=17.1515; T3=19.502

### 3.2 Effects on Egg Quality

The normal avian egg consists of the Shell and Shell membrane, Albumen and Chalazae and Yolk. The quality of the egg, its marketability and chances of hatchability is dependent an these factors added to the weight.

#### 3.2.1 Egg Weight

The analysis of the egg weight in this study is presented in Table 2. The results indicated that the weight of the eggs laid during the treatment were higher than those of the control. The mean weight of the control eggs of 52.19±1.73g was found to be within the normal range of 50-55g for Gallus sp (SMITH, 1996). The differences between the weights of the control and those of the treatments were highly significant ($P \leq 0.01$).

SMITH (1996) had observed that eggs which are 10% smaller than the average may contain too small a yolk and therefore insufficient nutrients, while those with 10% larger weight may be double yolked and this may prove infertile or produced deformed chicks. This means that heavier eggs produced by the birds that ingested oily feeds may not hatch when incubated. KING AND LEFEVER (1979) had shown that embryo mortality can be as a result of the toxicity of oil and/or interception of normal gaseous exchange, whilst SZARO *et al.* (1978) indicated that only minute quantities of oil are needed to produce marked reductions in Mallard egg hatchability. This would mean that oil pollution particularly in near shore/coastal environment, where aquatic birds often feed (and therefore would ingest oil particles) could seriously affect aquatic bird populations by decreasing egg hatchability.

### 3.2.2 Egg Albumen

The analysis of the egg albumen height is shown in Table 2, which shows the mean height for the control to be 6.06±0.22 compared to 5.49±0.12, 5.68±0.02 and 5.3±0.13 for T1, T2 and T3 respectively. The differences between the values for the control and treatment cases were found to be highly significant (P≤0.05).

The albumen acts as a source of moisture and protein for developing embryo and absorbs products excreted by the embryo. As it is composed largely of water it has high specific heat and therefore protects the embryo from large fluctuations of temperature (SMITH, 1996). This means that any reduction in the size of the albumen will affect its moisture, protein content and other functions and hence the chances of survival of the embryo (hatchability of the egg). VAN TIJAN (1972) noted that the height of the thick albumen is an important index of egg quality parameter, since is better maintained in the centre of an egg and its bactericidal properties ensures the prevention of egg spoilage.

**Table 2:** Egg quality analysis before and after treatment.

| | Pre-Treatment | | | Treatment 1 | | | Treatment 2 | | | Treatment 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days of Sample | Egg Weight (g) | Albumen Height (cm) | Haugh Unit (HU) | Egg Weight (g) | Albumen Height cm | Haugh Unit (HU) | Egg Weight (g) | Albumen Height (cm) | Haugh Unit (HU) | Egg Weight g | Albumen Height cm | Haugh Unit (HU) |
| 1 | 48.26 | 5.31 | 75.93 | 60.0 | 5.71 | 72.48 | 59.32 | 5.68 | 71.02 | 69.40 | 5.72 | 71.41 |
| 2 | 48.80 | 6.46 | 81.73 | 58.81 | 5.75 | 74.16 | 55.0 | 5.64 | 71.82 | 56.60 | 4.78 | 63.50 |
| 3 | 63.45 | 6.80 | 85.08 | 61.56 | 4.90 | 66.87 | 58.73 | 5.66 | 72.28 | 64.48 | 5.73 | 72.73 |
| 4 | 55.0 | 6.50 | 86.10 | 65.0 | 4.87 | 65.37 | 58.62 | 5.68 | 71.14 | 66.0 | 5.13 | 68.65 |
| 5 | 47.0 | 6.82 | 88.06 | 58.18 | 5.45 | 71.80 | 58.13 | 5.57 | 67.42 | 63.34 | 5.15 | 69.17 |
| 6 | 50.0 | 5.53 | 78.59 | 56.0 | 5.73 | 73.60 | 58.18 | 5.62 | 68.22 | 65.34 | 4.91 | 65.86 |
| 7 | 54.78 | 6.48 | 85.61 | 52.0 | 5.82 | 74.68 | 69.18 | 5.66 | 70.91 | 68.53 | 5.68 | 70.95 |
| 8 | 58.0 | 5.62 | 78.69 | 49.60 | 5.73 | 73.40 | 70.54 | 5.64 | 68.17 | 58.0 | 5.14 | 68.85 |
| 9 | 50.0 | 6.91 | 95.75 | 57.60 | 5.80 | 74.14 | 70.0 | 5.82 | 66.36 | 68.42 | 5.82 | 74.90 |
| 10 | 46.70 | 5.16 | 84.10 | 50.46 | 5.12 | 68.86 | 60.73 | 5.80 | 72.76 | 65.60 | 4.93 | 66.07 |
| $\bar{x}$ | 52.19 ±1.73 | 6.06 ±0.22 | 83.96 ±2.32 | 56.92 1.57 | 5.49 ±0.12 | 71.52 ±1.36 | 61.83 ±1.82 | 5.68 ±0.02 | 70.01 ±0.92 | 64.57 ±1.36 | 5.30 ±0.13 | 69.01 ±1.28 |

t-Test values:

Egg weight (between pre-treatment): T1 = 1.936; T2 = 3.9447; T3 = 5.0659

Albumen height: T1 = 2.04; T2=1.358; T3=2.715

Height Unit: T1 = 4.8965; T2 = 5.4908; T3 = 5.8844

The results of this study indicate that with the reduction of the albumen height, the eggs laid by birds within T1, T2 and T3 are most likely to be spoilt with time and encounter reduced hatchability.

### 3.2.3 Haugh Unit

The Haugh Unit is an expression relating egg weight and height of thick albumen (HAUGH, 1937) and is the most widely used research measure of albumen quality. The Haugh unit value has proved to be more significantly correlated to more quality measurements than any other (HAWTHRONE, 1950).

The result of this study as shown in Table 2 showed that the Haugh Unit values of 83.96, 71.52, 70.01 and 69.01 were obtained for the control T1, T2 and T3 respectively. The differences between the values for the control and the treatment cases were found to be highly significant ($P \leq 0.05$) and could be attributed to the ingestion of oily food by the birds. IZAT *et al.* (1986) had reported the mean HU of 85.00 for fresh eggs collected from hens of 29 weeks. CUNNINGHAM *et al.* (1966) had indicated that season had no significant effect an egg quality but the decline an Haugh Units occurred as the flock aged.

The HU of 83.96 recorded for the control indicated that the values were comparable of those of IZAT *et al.* (1986), while the lower values of 69.01 - 71.52 recorded for the treatment cases were indicative of the stressed conditions of the hen, which could be compared with ageing syndrome indicated by CUNNINGHAM *et al.* (1960). The result of this study showed that the egg quality laid by the birds under treatment were significantly reduced, and this would affect the marketability and hatchability of such eggs as they would be prone to spoilage easily.

### 3.3 Egg Shell Thickness

Shell and Shell membranes consist mainly of calcium carbonate and form a protective surrounding for the soft inside of the egg. The Shell is perforated by pores which allow moisture and gaseous exchange between the egg and particularly the embryo and the exterior (SMITH, 1996). Both the shell and its membrane fulfil a mainly protective function and in addition act a source of calcium for the developing egg.

The results of this study as shown in Table 3 show that the mean shell thickness for the control to be 0.34cm while 0.23,0.20 and o.19 were recorded for T1, T2 and T3 respectively. The differences between the control values and the treatment were found to be highly significant. The 0.34cm shell thickness recorded for the control in this study was found to be comparable to the 0.36cm (355 micrometer) indicated as normal shell thickness (SMITH, 1996). The significant reduction in the shell thickness would affect the protective function of the shell, and consequently increases the chances of spoilage of the egg.

**Table 3:** Analysis of egg shell thickness (cm)

| Days of Sampling | Pre-treatment | Treatment 1 | Treatment 2 | Treatment 3 |
|---|---|---|---|---|
| 1 | 0.38 | 0.26 | 0.25 | 0.26 |
| 2 | 0.36 | 0.25 | 0.26 | 0.25 |
| 3 | 0.38 | 0.27 | 0.24 | 0.22 |
| 4 | 0.42 | 0.24 | 0.20 | 0.20 |
| 5 | 0.28 | 0.24 | 0.20 | 0.19 |
| 6 | 0.36 | 0.22 | 0.19 | 0.20 |
| 7 | 0.32 | 0.20 | 0.19 | 0.18 |
| 8 | 0.30 | 0.20 | 0.17 | 0.15 |
| 9 | 0.29 | 0.20 | 0.14 | 0.13 |
| 10 | 0.34 | 0.20 | 0.15 | 0.13 |
| $\bar{x}$ | $0.34 \pm 0.01$ | $0.23 \pm 0.01$ | $0.20 \pm 0.01$ | $0.29 \pm 0.01$ |

t values for egg shell thickness analysis (between pre-treatment and various treatments):
T1 = 5.4455; T2 = 6.9307; T3 = 7.4257

### 3.4 Yolk Index

The yolk functions as a food reserve and when the click hatches, it is easily absorbed. The presence of this food reserve enables the clicks to survive for several days after hatching without food and water.

The analysis of the yolk index is presented in Table 4 , which shows the value for the control to be 1.18 compared to the 1.004, 0.99 and 1.00 recorded for T1, T2 and T3 respectively. The observed differences were found to be highly significant ($P>0.05$). This observed difference in the yolk index would be attributable to ingestion of crude oil by the treatment cases. This would lead to embryonic mortality, which ALBERS (1977) noted to be caused by the aromatic fractions of the oil. The same author indicated that whatever the mode of action, oil kills rapidly and that the effect is observed within 96 hours of treatment.

**Table 4:** Analysis of yolk index

| | Pre-treatment | | | Treatment 1 | | | Treatment 2 | | | Treatment 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days of Sample | Yolk Height | Yolk Diam. | Yolk Index | Yolk Height | Yolk Diam. | Yolk Index | Yolk Height | Yolk Diam. | Yolk Index | Yolk Height | Yolk Diam. | Yolk Index |
| 1 | 3.25 | 2. 85 | 1.14 | 3.56 | 3.10 | 1.15 | 3.10 | 3.60 | 1,19 | 3.75 | 3.10 | 1.21 |
| 2 | 3.95 | 3.46 | 1.14 | 3.55 | 3.35 | 1.06 | 3.20 | 3.20 | 1.00 | 3.21 | 3.10 | 1.04 |
| 3 | 3.21 | 2.77 | 1.16 | 3.10 | 2.82 | 1.10 | 3.10 | 3.20 | 0.97 | 3.75 | 3.44 | 1.09 |
| 4 | 3.20 | 2.81 | 1.14 | 3.00 | 3.54 | 0.85 | 3.12 | 3,13 | 1.00 | 3.20 | 3.10 | 1.03 |
| 5 | 3.36 | 2.92 | 1.15 | 3.45 | 3.45 | 1.00 | 3.20 | 3.46 | 0.92 | 3.33 | 3.41 | 0.98 |
| 6 | 3.45 | 2.60 | 1.33 | 3.26 | 3.32 | 0.98 | 3.36 | 3.40 | 0.99 | 3.21 | 3.41 | 0.94 |
| 7 | 3.66 | 2.90 | 1.26 | 3.00 | 3.00 | 1.00 | 3.35 | 3.42 | 0.98 | 3.52 | 3.57 | 0.99 |
| 8 | 3.40 | 3.12 | 1.09 | 3.21 | 3.46 | 0.93 | 3.26 | 3.32 | 0.98 | 3.22 | 3.53 | 0.91 |
| 9 | 3.42 | 2.70 | 1.27 | 3.18 | 3.22 | 0.99 | 3.20 | 3.48 | 0.92 | 3.18 | 3.50 | 0.91 |
| 10 | 3.57 | 3.10 | 1.15 | 3.36 | 3.41 | 0.98 | 3.12 | 3.38 | 0.92 | 2.89 | 3.21 | 0.09 |
| $\bar{x}$ | 3.40 ±0.05 | 2.92 ±0.08 | 1.18 ±0.02 | 3.27 ±0.07 | 3.23 ±0.07 | 1.004 ±0.03 | 3.20 ±0.03 | 3.26 ±0.08 | 0.99 ±0.02 | 3.33 ±0.09 | 3.38 ±0.06 | 1.00 ±0.03 |

t- values for yolk index between control and treatments: T1 = 5.176; T2 = 5.588; T3 = 5.290.

## 4 Conclusions

The presence of crude oil and its petroleum product in the environment following oil spill incidences has often resulted to detrimental effects an crops and animals. The results of this study has shown that when birds ingest oil contaminated diets, as would occur in oil polluted areas, the impacts would lead to significant reduction in the number of eggs laid, increased egg weight and albumen height which reduces the Haugh unit. This would consequently reduce the quality of the egg. Other observed effects such as reduction in yolk index and shell thickness would generally reduce the hatchability of the egg, enhance egg spoilage and loss of market value.

These observations indicate that where oil spillage occurs, these impacts would further endanger the survival of the birds. It is therefore suggested that clean up operations of coastal, near shore and other polluted areas should be carried out as quickly as possible to reduce any undue prolonged effects an birds, particularly those associated with their feeding activities.

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