Development of a Mechanical Family Poultry Feeder

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Abstract
The growing need for poultry products by consumers has urged the necessity for small and medium scale poultry farmers to meet up the demand since they supply the bulk need of the market especially in the developing countries. There exist the need to produce birds that will meet the market standards within the shortest time without straining the farmer’s time, resources and energy. This project was done in an effort to provide a labour/time saving mechanically operated automatic feeder that will optimize feeding of birds in family poultry and small/medium scale poultry farms. The density, moisture content, angle of repose and the coefficient of friction between the feeds and the bin material of the feeder were used in the design analysis. The model feeder which could feed twenty five (25) adult poultry birds for one week was constructed using sheet metal, wood, and spring as construction materials. The feeder trough and hopper are of gauge 20 metal sheet. In operation, the trough held 5 kg of feeds thus pulling the stopper to block the hopper for the introduction of the feed. The feeder set up dispensed its content to twenty five (25) adult layers for a period of one week. From the feeder evaluation using Roman Brown layers, the consumption efficiency was 70 % per week. The feeding convenience for the twenty five (25) birds (layers) of average weight of 1.53 kg was about 80 % with permissible wastage of 30 %. Cost of production is ₦14,000:00 ($86:00).

Keywords: design, construction, testing, family, poultry, feeder.

INTRODUCTION
Over the last 20 years, due largely to genetic selection but partially to improvements in nutrition, there has been a substantial decrease in the time it takes to grow a broiler to market weight. Much of this improvement is attributed to increased food intake (Mack, et al, 2005). The invention of improved mechanical feeding system led to a dramatic reduction in stress due to the elimination of manual feed sorting and relocation of birds by weight, more efficient feeding, less disturbance by staff, the elimination of meal replacement due to better weight control monitoring and increased productivity due to less handling. All of these factors contribute to the realisation of the birds’ genetic capabilities. According to Francis (2001), there is also increased efficiency for the producer as no time is required to correct uneven bird weights and staff will have more time to devote to animal husbandry.

The term “Family Poultry” refers to any genetic stock of poultry (unimproved or improved) raised intensively, semi-intensively or extensively in relatively small numbers (Geoffrey, 1973; Day, 1983; Luciano, 2005).

Most of the 826 million people still suffering from malnutrition and approximately 1,200 million people living on less than one US$ per day are to be found in developing countries, especially in the arid zones of Africa and Asia (UNDP, 2007). Family poultry (FP) represent an appropriate system for supplying the fast growing human population with high quality protein and providing additional income to resource-poor small farmers, especially women, although requiring low levels of inputs (i.e. housings, cages, feeds, breeds, vaccines, drugs, equipment and time/attention). Family poultry contributes significantly to food security and poverty alleviation.

Moreover, Family poultry constitute an important component of the agricultural and household economy in the developing world, a contribution that goes beyond direct food production as well as job and income generation for small farmers. (Guèye, 2002)

Poultry Feeders for Developing Countries
Before the development of the automatic feeder technology, people were used to the conventional method of feeding chickens which is by filling containers with grains and foods manually. The main problem encountered by using this method is, the need to continuously provide the food, be alert and conscious of the food remaining in cages by the breeders. The sufficient amount of the food provided also cannot be determined clearly. There is much waste and is non-economical. Breeders also find that it is difficult to manage their business effectively because they need to be around the cages every now and then to monitor the poultry. There are various designs of feeding equipment which vary from country to country as stated by Nesheim et al. (1979). Irrespective of the method of design, the guiding principles in feeder design is that it must be easy to
fill and clean; built to avoid waste; arranged such that fowls cannot roost on them; and constructed with durable materials in such a manner that so long as they contain feed at all, the fowl will be able to reach it with good feeding space (Nesheim et al., 1979).

For about sixty-five years ago, almost all poultry feed was distributed by hand to birds mainly in square bottom troughs, wooden or metal feeders. Later mechanical and automatic feed systems were invented and they help to modify the feeding system, save labour and increase production. Nowadays, the automatic feeding system is available in the market. This method is actually better than manual. But, there are also some problems and weaknesses that need to be overcome and solved, firstly, the automation, of the computerized method is suitable and caters more to the commercial purpose. Also there is the need for high investment for equipment and devices, and precise manual guide and knowledgeable as well as skilled people to operate the machines. More workspace is needed to put and assemble the automatic system. These are not favourable to the family poultry and small scale poultry operators.

A review of literature, of the rural population in Nigeria reveals that 80% are small scale farmers. A survey of the livestock industry in most areas in Nigeria indicates that automatic or mechanical feeding equipment are unavailable and where available they are unreliable due to unsteady power supply or too expensive to maintain (Onyebuchi, 1995; Alabi and Aruna, 2005). As a result of such limiting conditions, sophisticated metering poultry feeders appear increasingly as large scale commercial proposition. The challenges which continually faces the poultry industry, especially in African countries and elsewhere in the developing world is the provision of suitable design and economical houses to provide optimum environment for maximum growth and production with economical use of feed (Patrick, 1989). There is therefore the need for development of an efficient family poultry feeder.

OBJECTIVES OF THE STUDY
Family poultry and small/medium scale poultry farming are widely practiced by majority of African poultry farmers. The labour involvement and time demand for these poultry ventures make it arduous for most of the farmers. To ameliorate these problems in majority of the rural communities, improved mechanical feeders are required in order to maximize time and reduce labour (Onyebuchi, 1995). This project attempts at solving the problems of high labour/time demand, feed wastage, and irregular/unsteady power supply for feeders associated with small/medium scale poultry farms and family poultry.

COMPONENT PARTS AND FABRICATION OF THE MODEL FEEDER
The hopper, inner spring casing, stopper, link tunnel, trough funnel, grille cap, distributor cone, feeder trough and the rod stands are the components of the feeder.

The Hopper: The hopper is made of gauge 20 sheet metal cut 124 cm by 61.7 cm and bent end to end to form the cylindrical portion of the hopper with diameter 41.2 cm. A 50 cm by 124 cm sheet is cut into a trapezoid which is bent round and welded end to end to form a frustum with 41.2 cm at one end and 21 cm at the other end. This frustum of height 50 cm is welded from the 41.2 cm diameter end to the end of the cylindrical hopper. These two sections (cylindrical and conical) welded together forms the hopper having a cylindrical top with a conical bottom, with a total height of 111.7 cm.

Inner Spring Casing: This component which is made of aluminium panel sheet measured 110 cm by 60 cm which is bent to form a cylinder of diameter 20 cm. The ends are joined by anchoring the edges. Then, 10 cm height from one end is cut at intervals to form prongs with flat end 2 cm wide, having spaces of 5 cm between prongs.

Stopper: This is made out of 2 cm thick hard wood. The circular shaped stopper, 25 cm in diameter is cut out of a 30 cm² wood. Using construction to determine the centre of the circle, holes are made on the wood. Firstly, four 0.5 cm diameter holes are made 1 cm off the centre at 90° to each other. Then eight 2 cm width holes are created 1 cm from the circumferential end of the stopper with 5 cm space interval between these holes.

Link Tunnel: This component composed of two parts is also made of aluminium panel sheet. The first part is cylindrical in shape with 21 cm diameter and made from a 30 cm by 63 cm panel sheet joined end to end with the edges hammered together. The second part is a frustum with of 21 cm top diameter and 30 cm bottom diameter made of aluminium panel sheet. This shape is developed by cutting a 90 cm by 20 cm aluminium panel sheet then applying the steps on development of a conical frustum. The two parts are joined together by sliding the cylindrical portion through the frustum part until its end with open flap hooks the end mouth of the frustum. (Goklap and Bundy, 2010)

Grille Cap: This is made simply from thin metal wire which is bent to form two circles each of 21 cm and 46 cm diameter respectively. With the aid of a wrapping foil, the thin metal circles are wrapped around the circumference. Then, aluminium panel sheet is cut into several trapezoid (15 in number) of sides 1 cm and 2 cm and height 20 cm. These
trapezoids are bent at the 1 cm and 2 cm ends to form a small circular tunnel for the passage of the wrapped circular wires. When these panel plates are fixed to both wires a grille is formed.

**Distributor Cone:** This is a 24 cm diameter cone of height 30 cm made of aluminium panel sheet. This is developed from a 72 cm by 30 cm sheet cut in accordance with the conical development rule as contained in. (Goklap and Bundy, 2010)

**Feeder Trough:** A 10 cm by 138 cm aluminium sheet metal of gauge 20 is welded at one end with a circular sheet of same material of diameter 46 cm to form a cylindric container. Then 3 pieces of 2 cm diameter hollow pipes of height 15 cm are welded to the side of the container so as to form a tripod. Holes are then bored centrally on these pipes and a 2” nut welded to each pipe about the holes to allow the passage of the screw measuring 5 cm in length welded to a 2 cm diameter circular end which serves as a knob used for tightening or loosening.

**Rod Stands:** These are made from stainless steel rods of height 20 cm. They are three in number. They fit into the hollow pipes and are then screwed tight to make the stands hold firm in position. Other materials used in the feeder construction include; wire and spring and mild U-metal screw.

**Wire and Spring:** The wire and spring is the main mechanism that controls, regulate and co-ordinate the metering of the feeds from the hopper to the feed trough. The arrangement is such that the wire runs from the ceiling hoist to about 75.5 cm into the hopper from where it hooks up the spring at one end. The other end hooks up the U-rod embedded in the stopper from where another wire continues from the opposite end of the stopper to the feeder trough. It is attached to a U-rod at the base. The spring possesses the necessary elastic strength, to suspend the hopper plate as it is pulled downwards by the weight of feed in the trough to block further discharge of feeds. When the feed quantity in the trough reduces to a certain level, it causes decrease in weight which in turn makes for a pull of the spring. This pulling leads to the raising of the stopper of the hopper which allows for an opening for the discharge of feed once more to the trough.

**Mild U-Metal Screw:** The U-shaped metal has both ends threaded to allow for bolting. This U-rod has the main function of holding the spring mechanism to the trough. Bolts are used to hold the two ends of the rod as it pass through the holes made on either the stopper or the base of the trough. With the aid of washers, the rods are held steadfast to the feeder mechanism.

A pictorial drawing of the developed feeder is shown in Fig.1 (See Appendix). Fig.2 is the component parts of the feeder with dimensions. A photograph of the feeder during evaluation is shown in Fig.3

**MATERIALS AND METHODS**

Commercial feeds for poultry birds in Nigeria were used for design analysis and evaluation of the mechanical family poultry feeder. They are the layer marsh, growers marsh, broiler finisher and broiler starter. The physical properties of the feeds determined were sizes, density, angle of repose/coefficient of friction and moisture content.

**Size of Feeds**

Sizes of feeds were obtained from the hand book of the producing company, Grand Cereals Ltd. A subsidiary of UAC Nig. Plc., Jos, Plateau State, Nigeria. They were further confirmed by sieve analysis using a set of BS 41 sieves.

**Density of Feeds**

The density of feeds for the five samples of poultry feeds were determined experimentally and calculated using the formula:

\[ \rho = \frac{M}{V} \]  

Where:

- \( \rho \) = density of feed
- \( M \) = mass of feed
- \( V \) = volume of feed

**Angle of Friction**

To design the hopper the angle of incline should be such that a free flow of feed is guaranteed or enhanced. The angle of friction was determined by pouring 5 kg of feed on a 1.5 mm thick mild steel
sheet on the angle of friction device developed by Umogbai (2009). Ten trials were carried out and the mean determined as follows:

\[ \theta = \frac{\sum \theta}{N} \]

Where:
- \( \theta \) = angle of friction
- \( N \) = number of measurements
- \( \sum \theta \) = sum total of measured angles.

Moisture Content of the Feeds
The oven drying method at a temperature of 105°C for 24 hours was used to determine the moisture content of the feeds and computed as follows:

\[ mc = \frac{m \cdot mf}{mf} \times 100 \]

Where:
- \( mc \) = moisture content of feed sample
- \( m \) = mass of wet feed sample (ordinary state of the feed)
- \( mf \) = mass of dried feed sample.

Feed Metering Spring/Hopper/Trough
The spring mechanism shown in fig 1 and 2 controls, regulates and co-ordinates the metering of the feed from the hopper to the feed trough. The performance and efficiency of the spring was assessed using Hooke’s law of elasticity (Wikipedia, 2010). The elasticity and maximum strength of the steel spring was determined in the civil engineering laboratory, University of Agriculture, Makurdi.

The original length of the un-stretched spring was measured using a meter rule. Weights of 1 kg, 2 kg, 3 kg, 4 kg and 5 kg were separately used to determine the springs tensile strength and the extensions were recorded.

Assumptions made for the design are:
- That each bird can consume 0.9 kg of feeds per week amounting to 0.13 kg per day. (Williamson and Payne, 1978)
- That the bin is to be put to effective use for at least 5 years.
- The longest time a farmer can be away is one week.
- The hopper could contain one bag of poultry feed which is 25 kg.
- The feed trough could carry a maximum load of 5 kg at a time. This value is based on the maximum stress capacity of the spring.


The calculated parameters and their results are shown on table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual capacity of bin and hopper</td>
<td>0.27 m³</td>
</tr>
<tr>
<td>Feed pressure on the feeder wall</td>
<td>353.1 N/m²</td>
</tr>
<tr>
<td>Dynamic lateral pressure</td>
<td>391.1 N/m²</td>
</tr>
<tr>
<td>Horizontal force acting per unit length</td>
<td>745.9 N</td>
</tr>
<tr>
<td>Circumferential stresses on hopper</td>
<td>331.2 KN/m²</td>
</tr>
<tr>
<td>Longitudinal stresses</td>
<td>1.66 KN</td>
</tr>
<tr>
<td>Shear stresses for the trough</td>
<td>316.6 N/m²</td>
</tr>
<tr>
<td>Thickness of metal sheet for construction</td>
<td>0.58 mm</td>
</tr>
<tr>
<td>Load on trough stand</td>
<td>56.9 N</td>
</tr>
<tr>
<td>Shear stresses on Spring</td>
<td>483.9 N/m²</td>
</tr>
<tr>
<td>Axial deflection of spring</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Stiffness of the spring (spring rate)</td>
<td>0.21 N/m</td>
</tr>
<tr>
<td>Spring diameter</td>
<td>3.9 mm</td>
</tr>
</tbody>
</table>

PARAMETERS AND THEIR RESULTS
To calculate the number of birds to feed on the feed trough; from the linear feeding space of poultry birds at six (6) weeks is 5.8 cm (which is also the length of the grille cap). (Oluyemi and Roberts, 1979)

Thus to get the linear length of the trough \( Lt \):

\[ Lt = \pi D \] (Formula for perimeter of a circle)

\[ = 3.14 \times 46 \]
\[ = 144.53 \text{ cm} \]

It therefore follows that for a trough of 144.532 cm, the total number of birds it can accommodate during feeding is calculated thus;

\[ \text{Number of birds} = \frac{\text{length of trough}}{\text{Linear feeding space}} \]
\[ = \frac{144.532}{5.8} \]
\[ = 24.92 \approx 25 \text{ birds} \]

Therefore total number of birds the feeder can accommodate is twenty-five (25) birds.

1 bird per day --------------- 130 gm of feed (Williamson and Payne, 1987).

\[ \frac{25 \text{ birds per day}}{1 \text{ bird per day}} \times \frac{130 \text{ gm feeds per day}}{25 \text{ birds per day}} = 3250 \text{ gm feed per day} \]
\[ = 3.25 \text{ kg of feed per day} \]

25 kg of feed will sustain 25 birds for \[ \frac{1 \text{ week}}{7.69 \text{ days}} \]
\[ = 7.69 \text{ days (1 week adopted)} \]
From the calculations above, it therefore means that, 25 birds will consume 25kg (one bag of commercial poultry feed) of feed for one week.

**PERFORMANCE EVALUATION**

Testing was carried out on the feeder to ascertain its functionality and determine the efficiency of the feeder. Twenty-five (25) Roman brown birds (layers) were used for evaluation at the poultry unit of the University of Agriculture, Makurdi research farm. The evaluation was monitored for duration of three weeks. The performance of the developed feeder was compared with the pan feeder which is the popular feeder used by poultry farmers in Nigeria. The pan feeder is also the type used in the University of Agriculture, Makurdi poultry research farm. Factors considered in the evaluation were feed consumption, number of eggs produced per day, weight-change per bird, feeding convenience, feed wastage, and feeding efficiency.

**Determination of Feed Consumed**

Blanco and Grook’s formula was used for the evaluation.

\[ Mc = Ms1 - (Ms2 + Ms3) \]

(Blanco and Grook, 2006)

Where:

- \( Mc \) = mass of feed consumed by birds during one week (kg)
- \( Ms1 \) = the mass of feed introduced into the feeder trough and hopper (kg)
- \( Ms2 \) = mass of feed in both hopper and trough at the end of one week (kg)
- \( Ms3 \) = mass of feed wasted to the floor in one week (kg)

**Number of Eggs Produced**

This was done by counting the number of eggs produced by the birds per day.

**Weight Change**

A digital weighing balance was used to measure the weight change per bird after one week feeding.

**Feeding Convenience**

Convenience is a function of the number of birds that will be permitted continuous feeding to the number that have to wonder a while before they have opportunity to feed. This occurs at any time \( t \) when the twenty-five (25) birds used try to feed from the feeder at the same time. For the first day, it occurred at about three (3) hours into the evaluation process. The whole birds tried to feed from the feeder trough but six (6) birds could not find comfortable space around the feeder. They wonder off until a space was created by voluntary withdrawal of the birds already feeding. This situation repeated itself at different times at different days of the week with the feeding convenience calculated using Johnston and Cianmiel’s equation.

\[ Fc = \frac{\sum_{t=1}^{N} (\text{INT} - Nt) + \text{NT}) \times 120}{T} \]

(Johnston and Gannmil, 2006)

Where:

- \( Fc \) = Feeding convenience for the birds for one week
- \( N \) = Seven (7) days involved
- \( Nt \) = Number of birds wondering around for space at maximum feeding in a day
- \( NT \) = Total birds sample = twenty-five (25)

**Feed Wastage from the Trough**

For the duration of experimentation, the poultry pen where this evaluation is set up was swept twice daily, so that the amount of feed wasted to the floor was collected and weighed to determine the mass of wastage.

\[ Wt = \sum_{i=1}^{N} Wn \]

(Johnston and Gannmil, 2006)

Where:

- \( Wt \) = wastage from the trough per week
- \( N \) = Seven (7) days involved
- \( Wn \) = mass of waste to the floor collected per day.

**Efficiency of the Feeder**

This involves the application of the values derived above as presented in Guéye’s efficiency formula (E):

\[ E = \frac{\text{mass of feed consumed by birds} - \text{mass of wastage}}{\text{mass of feed consumed by birds}} \times 100 \]

(Guèye, 2002)

**OPERATION OF THE FEEDER**

The main parts of the feeder of are the hopper (upper portion), the link tunnel (mid section) and the trough (lower portion). These three parts are easy to detach and couple for ease of handling, cleaning and transportation. The steel spring is the main mechanism that regulate and co-ordinate the metering of the feeds from the hopper to the feed trough. The spring possess the elastic strength to suspend the plate that is pulled downwards by the weight of feed in the trough to block excess discharge of feed. When the quantity of feed in the trough reduces, the decrease in weight causes a pull of the spring which then opens the mouth of the hopper for release of feeds to the trough.

About five (5) kg of feed is initially fed into the trough so that on hanging it pulls the stopper to close the hopper via the string wire hanging mechanism.
Then, twenty (20) kg (one bag) of the feed is discharged into the hopper.

RESULTS

Table 2 shows the physical properties of feeds used for the construction of the feeder and performance evaluation. Table 3 is the laboratory test for steel spring elasticity used for metering the feeds. Table 4 is the evaluation of the feeder for a duration of three weeks, while table 5 gives the performance and operating parameters between the developed feeder and the pan feeder.

Table 2: Physical properties of feeds used for construction and performance evaluation

<table>
<thead>
<tr>
<th>Feed name</th>
<th>Available size (mm)</th>
<th>Angle of repose (ø)</th>
<th>% moisture content</th>
<th>Coefficient of friction (µ)</th>
<th>Friction (G)</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growers mash</td>
<td>6</td>
<td>46.6</td>
<td>17.46</td>
<td>0.62</td>
<td>32</td>
<td>485.15</td>
</tr>
<tr>
<td>Broiler starter</td>
<td>3</td>
<td>43.0</td>
<td>14.24</td>
<td>0.62</td>
<td>31.6</td>
<td>629.61</td>
</tr>
<tr>
<td>Chick mash</td>
<td>3</td>
<td>46.8</td>
<td>16.9</td>
<td>0.71</td>
<td>35.2</td>
<td>598.00</td>
</tr>
<tr>
<td>Broiler finisher</td>
<td>5</td>
<td>44.4</td>
<td>16.80</td>
<td>0.80</td>
<td>38.3</td>
<td>635.54</td>
</tr>
<tr>
<td>Layers mash</td>
<td>6</td>
<td>52.1</td>
<td>15.82</td>
<td>0.72</td>
<td>35.7</td>
<td>595.00</td>
</tr>
</tbody>
</table>

Table 3: Laboratory test for steel spring elasticity

<table>
<thead>
<tr>
<th>Mass (KG)</th>
<th>Length of unstretched spring (cm)</th>
<th>Length of stretched spring (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.5</td>
<td>25.2</td>
</tr>
<tr>
<td>2</td>
<td>24.5</td>
<td>27.0</td>
</tr>
<tr>
<td>3</td>
<td>24.5</td>
<td>29.5</td>
</tr>
<tr>
<td>4</td>
<td>24.6</td>
<td>32.1</td>
</tr>
<tr>
<td>5</td>
<td>24.8</td>
<td>34.7</td>
</tr>
</tbody>
</table>

Table 4: Evaluation of the feeder

<table>
<thead>
<tr>
<th>TEST FACTOR</th>
<th>WEEK 1</th>
<th>WEEK 2</th>
<th>WEEK 3</th>
<th>STANDARD ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Consumed per week (Kg)</td>
<td>16.51</td>
<td>17.66</td>
<td>18.22</td>
<td>±0.41</td>
</tr>
<tr>
<td>Feed Wastage (Kg)</td>
<td>8.49</td>
<td>7.34</td>
<td>6.78</td>
<td>±0.37</td>
</tr>
<tr>
<td>Consumption Efficiency (%)</td>
<td>66</td>
<td>71</td>
<td>73</td>
<td>±1.70</td>
</tr>
</tbody>
</table>

Table 5: Comparison of performance and operating parameters between the developed feeder and the pan feeder using roman brown layers

<table>
<thead>
<tr>
<th>Factors Considered</th>
<th>Developed feeder</th>
<th>Pan feeder</th>
<th>Remark(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Consumed per week</td>
<td>21.23 kg</td>
<td>17.46 kg</td>
<td>+ 3.76 kg feed consumed on developed feeder trough</td>
</tr>
<tr>
<td>Eggs Produced per day</td>
<td>19</td>
<td>17</td>
<td>+ 2 Eggs produced using developed feeder</td>
</tr>
<tr>
<td>Weight change per bird after one week Feeding</td>
<td>+ 0.23 kg</td>
<td>+ 0.35</td>
<td>− 0.12 kg due to more eggs by the developed feeder produce better layers</td>
</tr>
<tr>
<td>Feeding Convenience per bird per week</td>
<td>79.7 %</td>
<td>72.4 %</td>
<td>+ 7.3 % convenience using developed feeder</td>
</tr>
<tr>
<td>Feed Wastage per week</td>
<td>3.77 kg</td>
<td>7.53 kg</td>
<td>+ 3.76 kg wastage on developed feeder</td>
</tr>
<tr>
<td>Feeding Efficiency</td>
<td>85 %</td>
<td>70 %</td>
<td>Pan feeder has</td>
</tr>
<tr>
<td>Labour requirement per 200 birds</td>
<td>1 man</td>
<td>3 men</td>
<td>developed feeder saves cost of labour by 66.7 %</td>
</tr>
</tbody>
</table>

DISCUSSION

Five types of feeds were used to determine the physical properties of the available feeds. From table 2, it is observed that the growers mash, the layers mash and the broilers finisher have the largest sizes of 6 mm, 6 mm and 5 mm respectively. The sizes of the broiler starter and chick mash were 3 mm. The angle of repose did not vary significantly as the angle ranged from 43° to 46.8°. The moisture content was highest 17.46 percent for the growers mash and lowest 14.24 percent for the broiler starter. The coefficient of friction ranged from 0.62 to 0.8. There was however a noticeable variation in density of the feeds, with the broiler finisher having the highest density of 635.54 kg/m³. This was closely followed by the broiler starter with a density of 629.61 kg/m³. The chick mash, the layer mash and the growers’
mash have densities of 598.00 kg/m³, 595.00 kg/m³ and 485.15 kg/m³ respectively.

The laboratory test (five readings) for steel spring elasticity almost shows direct proportion to the load applied (table 3). The observed readings fully agreed with Hooke’s law of elasticity.

The performance evaluation test for a period of three weeks (table 4) shows that 16.51 kg, 17.66 kg and 18.22 kg of feed were consumed during the first, second and third weeks respectively. This shows a gradual increase in the amount of feed consumed per week. There is also a noticeable decline in feed wastage; 8.49 kg, 7.34 kg and 6.78 kg for first, second and third week respectively. Consumption efficiency increased from the first week through the second to the third week. The most likely reason for the recorded results is that probably the birds were getting more familiar with the developed feeder with increased usage. It was initially observed by the researcher and by other workers in the research farm that the birds were reluctant to feed from the developed feeder during the first few days.

Table 5 shows comparative performance and operating parameters between the developed feeder and the pan feeder. More feed was consumed per week when the developed feeder was used; 21.27 kg for the developed feeder and 17.46 kg for the pan feeder. This led to a higher number of eggs [nineteen (19) eggs] produced per day for the developed feeder as against seventeen (17) eggs per day for the pan feeder. Birds feeding from the developed feeder had an increase in weight of 0.23 kg per bird after feeding for one week while those feeding from the pan feeder gained 0.349 kg per bird. The relatively lower weight gained may be due the higher number of egg produced per day. The more the eggs produced, the more the time spent out of the feeding trough. However, the developed feeder has a higher feeding efficiency of 79.7 % per bird per week as against 72.4% for the pan feeder. Feed wastage per feeder per week is more (7.54 kg) for the pan feeder as compared to 3.77 kg for the developed feeder. The feeding efficiency was higher for the developed feeder. The developed feeder had 85% efficiency while the pan feeder had 70%. The feeder was produced at a cost of N14,000:00 (fourteen thousand naira only); ($86:00).

CONCLUSION
A mechanical poultry feeder has been designed, constructed and tested. The evaluation of feeder was carried out with roman brown layers (laying poultry birds) with an average weight of 1.43kg per bird. Results under a period of three weeks showed an average feeding efficiency of 85% per week. The feeding convenience for the 25 birds used as sample was 79.7% on the average permitting wastage of about 30%. These results are indicators of the fact that the feeder can be improved upon with adjustment of some of the defects such as feed blockage by the wooden stopper in the hopper and the grill cap alignment which encourage the wastage of feed discharged from the hopper into the feed through.

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REFERENCES


Automatic livestock feeders / www.poultycoop.org


APPENDIX

Fig 1: Pictorial drawing of the developed feeder

<table>
<thead>
<tr>
<th>Legend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-Ceiling joist</td>
<td>I-Operating string</td>
</tr>
<tr>
<td>B-String wire</td>
<td>J-Feeder tunnel</td>
</tr>
<tr>
<td>C- Stopper casing</td>
<td>K-Feed dispenser</td>
</tr>
<tr>
<td>D-Spring</td>
<td>L-Grill cap</td>
</tr>
<tr>
<td>E-Cylindrical hopper</td>
<td>M-Trough</td>
</tr>
<tr>
<td>F-Conical hopper</td>
<td>N-Knob</td>
</tr>
<tr>
<td>G-Wooden stopper</td>
<td>O-U-rod and nut</td>
</tr>
<tr>
<td>H-Link clip</td>
<td>P-Stand</td>
</tr>
</tbody>
</table>
Fig 2: Component parts of the developed feeder: (a) Hopper (b) Spring metering mechanism (c) Grill cap (d) Distributor cone