



## **Feed Wastage Management in Rabbit Production using Different Feeders**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author OOM designed and funded the study, collected the data and wrote the first draft of the manuscript. Author NFA managed the analyses of the study, donated experimental animals and provided location and supervised the study. Author AAB managed the literature searches and edited the final draft. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Aims:** This study was carried out to reduce the wastage caused by pawing effects of rabbits by introducing different feeder types.

**Study Design:** Completely Randomized Design

**Place and Duration of Study:** The study was carried out at Hephzibah and Beulah Farms, Ibadan, Nigeria between September 2018 and October 2018 (4 weeks).

**Methodology:** 36 rabbits in 1:2 ratio of growers to weaners respectively, were allocated to 3 different feeder types: Open Mouth Feeder (OMF), Tin Feeders (TF) and Hollow Mouth Feeders (HMF) in a Completely Randomized Design (CRD). The rabbits were fed a formulated diet in ration of 120g/day for the first 3 weeks of the experiment and 150g/day for the last week of the experiment, while water was supplied ad-libitum throughout the experiment.

**Results:** In the weaner rabbits, the results showed that although there was no significant difference ( $p>0.05$ ) in the Weight Gain and FCR across the 3 treatments throughout the experiment, Feed Intake and Feed wastage, varied statistically in the first week and numerically in subsequent weeks, the intake and wastage were highest and lowest respectively for rabbits fed with OMF type. For the

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grower rabbits: feed intake was significantly higher ( $p < 0.05$ ) with rabbits fed with the TF types across the last 3 weeks of the experiment, concurrently, feed wastage was significantly lower ( $P < 0.05$ ) with rabbits fed with the TF types across the last 3 weeks of the experiment. Weight gain and FCR on the other hand were not significantly different ( $p > 0.05$ ) across the 3 treatments for the four weeks of the experiment.

**Conclusion:** It was concluded that HMF encourage feed wastage in rabbit production, and as a replacement, OMF should be encouraged for weaner rabbits while TF is ideal for the grower rabbits.

**Keywords:** Rabbit; feeders; weight-gain; wastage.

## 1. INTRODUCTION

Rabbits are raised for a variety of purposes, which include: keeping as pets, the production of meat, fur, and wool; and for use as laboratory animals as well as for exhibitions [1-3] reported that small livestock species, including rabbits, have been promoted as tools in poverty alleviation programmes. Rabbits are particularly favoured for poverty reduction programmes on account of their low investment and early benefits, and subsistence on renewable resources for feeding, housing and general management. Thus, small-scale rabbit projects could be used as a vehicle for the poor to help themselves [4]. In addition to their meat, rabbits are used for their wool, fur, and pelts, as well as their nitrogen-rich manure and their high-protein milk [5]. However, rapid increase in human population has exerted pressure on the available land leading to an increasing shift towards more intensive and semi intensive systems of rabbit rearing [6,7]. The intensive system is the most widely adopted practice in rabbit production, the intensive system of management is widely practiced by rabbit farmers because, it enhances effective monitoring and also the farmers are able to know at a glance, the growth and health conditions of the animals [8]. In this system, feeding management is on commercial feeds (total dependence on prepared concentrate feed from the feed mill) which are compounded to increase growth rate and to minimize labor requirements [9,10]. The farmers' aim is to maximize profit by reducing the cost of production in every possible way. Considering the numerous factors which come into play in rabbit production and management in Nigeria such as: availability of feed ingredients, feed wastage due to "pawing", insufficiency and high cost of giant and fast-growing breeds and poor management techniques; these have been issues of great concern. Research scholars have embarked upon finding a lasting solution to these problems and in order to address these issues, tangible successes have been achieved in

different areas such as use of alternative feed ingredients, use of hybrid breeds for improved growth performance, the use of different feeders to reduce wastage and also introduction of certain management techniques that improve rabbits' performance. Feed wastage in rabbit production has been the most widely addressed lately as other challenges have been solved to a reasonable level. Rabbits have been identified overtime as having high propensity to waste their feed, therefore, the addition of more feed increases per capita production cost of the rabbits, which in turn, reduces the profit margin of the rabbit farmer. It is therefore important to use feeding systems and methods that reduce rate of consumption but most importantly feed wastage, to an amount that keep the animal in a good physical condition and promotes its normal growth [11,12]. Feed wastage management in rabbit production is the utilization of every possible means which are not detrimental to the farmer, the environment and the rabbits; to reduce the rate at which feed meant for consumption are wasted by the rabbits through pawing or any other means outside egestion. Open mouth feeders, deep tin feeders and hollow-mouth feeders can reduce wastage by not permitting pawing and/or reducing the effects of pawing. Open mouth feeders are widely used due to its flexibility in terms of use, cleaning and adaptability for newly weaned rabbits. Deep troughs can allow for head dipping but while pawing is permitted, enough feeds do not reach the edge of the troughs to permit wastage. Semi-closed/hollow mouth troughs also allow for head passage while also reducing wastage.

### 1.1 Objectives of the Study

- Create a more effective way of reducing feed wastage in rabbit production, through the introduction of different feeding troughs
- To determine which of these feeders are most effective in feed wastage reduction and the effect on the growth rate of weaner-sized and grower-sized rabbits

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The field study of this research was carried out at the Rabbitry Section of Hephzibah and Beulah Farms, Moniya, Ibadan Oyo State, Nigeria. Ibadan is the capital of Oyo State and is approximately 500km from Abuja – The Federal Capital Territory of Nigeria. Ibadan is in the Tropical Savannah Climate, experiencing 2 major seasons – wet and dry seasons.

### 2.2 Experimental Animals

A total of 36 (Thirty-six) rabbits of both sexes comprising of 24 (twenty-four) weaners and 12 (twelve) grower rabbits were used for this study. 2 weaners and 1 grower were allotted to each replicate per treatment. From the 24 weaner rabbits used, 8 were randomly allotted per treatment, each treatment containing 4 replicates with 2 animals in each replicate. The growers were randomly allotted at 4 animals per treatment, each treatment containing 4 replicates with 1 rabbit each. Each rabbit was housed in individual cage for proper recording. Individual cage represents a replicate for each treatment and each cage contains either 2 weaner rabbits or 1 grower rabbit.

Experimental Design: Completely Randomized Design

Treatments

Treatments were the three different types of feeders used:

- Open mouth feeders (OMF)
- Tin feeders (TF)
- Hollow mouth feeders (HMF)

**Open Mouth Feeders (OMF):** These feeders were made from clay and cement, which were molded round a small eating bowl. This leaves the mouth of the end result (feeding trough) opened like any other eating bowl. It grants free access for the head and fore feet of the rabbits while eating. A total of twelve open-mouth feeders were made and were used. 8 feeders were allotted to the weaners and 4 to the growers.

**Tin Feeders (TF):** The tin feeders were constructed using aluminum roofing sheets. The sheets were folded from a relatively deep feeder, the base was sealed with the same product and hooks were made for attachment to the walls of

the cage. This is done to prevent the rabbits from pulling the feeders around the cages. A total of twelve tin feeders were also made and were randomly allocated to the rabbits. 8 feeders were allotted to the weaners and 4 to the growers.

**Hollow Mouth Feeders (HMF):** The construction of the hollow mouth feeders is similar to the open mouth feeders, as both clay and cement were used in the construction of both. But they differ in the shape of the openings. After molding the opened mouth feeder, another cover was made from clay and cement with smaller opening, this cover was then place as a cover over the opened mouth feeder initially molded and the cover was then cemented to the top of the opened mouth feeder. The hollow mouth feeder has a smaller opening but it allows for the entrance of the head and fore legs. A total of twelve hollow mouth feeders were also made and were randomly allocated to the rabbits. 8 feeders were allotted to the weaners and 4 to the growers.

#### 2.2.1 Housing

All rabbits were housed in a wire mesh cage of individual units. Each cage unit contains a replicate. The wire cage contains a water trough per cage and one feeding trough per animal. The base of the cage is also made from wire mesh for easy passage of the feed wasted, animal wastes and urine for easy collection; to the base of the cage. The wasted feed at the base of each cage is then measured for feed wastage.

#### 2.2.2 Feeding

Every morning before animals were fed, the ort was first measured and the feeders cleaned completely. This is done to ensure that fresh feed is offered every morning, it also aids the easy calculation of the feed intake and feed wastage. The animals were fed with the inclusion of 100% water added to moisten the feed and were fed 3 times daily: morning, afternoon and evening. For the first 3 weeks of the experiment, the rabbits were fed with 40g of dry matter feed in each ration, moistened with 40g of water while drinking water was also supplied *ad libitum* in a separate drinker; then the feed supplied was increased to 50g of dry matter and 50g of water in the last week of the experiment.

### 2.3 Data Collection

All data collected during this study were done in grams for accuracy and precision.

### 2.3.1 Feed intake

Feed intake was taken daily and derived from the calculation of the feed supplied, the amount wasted and the amount left in the feeder till the next morning (ort). The calculation used was:

Feed Intake (g) = Quantity Supplied(g) – (Ort + Quantity at the base of the cage-wasted) g

The Feed Intake was accumulated for each week, therefore the feed intake for the data analyses was weekly feed intake.

### 2.3.2 Feed wastage

This was also taken daily by measuring the amount of feed wasted at the base of the cage and added to the amount of feed left till the next morning. Feed wastage was accumulated for each week. Thus:

Feed wasted (g) = (Quantity at the base of the cage + ort) g

### 2.3.3 Growth

The growth rate of the animals was monitored on weekly basis. The rabbits were weighed at the end of every 7 days throughout the duration of the experiment.

### 2.3.4 Feed conversion ratio (FCR)

The feed conversion ratio of the animals was calculated at the end of each week, throughout the experiment:

Feed conversion ratio (FCR) =  $\frac{\text{Feed intake}}{\text{Weight gain}}$

## 2.4 Data Analysis

Data collected was subjected to analysis of variance (ANOVA) using SAS (2000) software package and means were separated using Duncan Multiple Range Test of the same package.

## 3. RESULTS

### 3.1 Weaner Rabbits' Performance

#### 3.1.1 Weekly feed intake of Weaner Rabbits fed with HMF, OMF and TF types

Table 1 shows the feed intake of weaner rabbits fed with OMF, TF and HMF types. The results show that in the first week only, the feed intake was significantly higher ( $P<0.05$ ) when the

rabbits were fed with the OMF (591.50) feeder compared to the HMF (488.25) and TF (462.00). However, there is no significant difference ( $P>0.05$ ) among the treatments in the subsequent weeks.

#### 3.1.2 Weekly weight gain Weaner Rabbits fed with HMF, OMF and TF types

Table 2 shows the weight gain of weaner rabbits fed with OMF, TF and HMF types. There was no statistical difference ( $P>0.05$ ) observed throughout the experiment between the weight gain of the rabbits fed with the three feeder types.

#### 3.1.3 Weekly feed conversion ratio (FCR) of Weaner Rabbits fed with OMF, TF and HMF types

Table 3 shows the feed conversion ratio of weaner rabbits fed with three types of feeders (OMF, TF and HMF). The results of the experiment show that no significant difference ( $P>0.05$ ) was observed among the three treatments. This observation was similar throughout the four weeks that the experiment lasted. Numerically, FCR was smallest at week 1, but later increased.

#### 3.1.4 Weekly feed wastage of Weaner rabbits fed with OMF, TF and HMF types

The feed wastage is presented on Table 4. The results indicate that the feed wastage by the rabbits fed with the OMF type (284.50) was significantly lower ( $P<0.05$ ) than the HMF (351.75) and TF (378.00) during the first week. However, there is no significant difference ( $P>0.05$ ) across the treatments in the subsequent weeks.

### 3.2 Grower Rabbits' Performance

#### 3.2.1 Weekly feed intake of grower rabbits fed with OMF, TF and HMF types

Table 5 represents the feed intake of grower rabbits fed with three different feeder types (i.e. OMF, TF and HMF). From the table, there was no significant difference ( $P>0.05$ ) in the feed intake patterns among the three treatments in the first week. However, feed intake in the second week was significantly higher ( $P<0.05$ ) in rabbits fed with TF than those fed with OMF. The feed intake in the HMF was not significantly different ( $P>0.05$ ) from the OMF and the TF. In the third

week, the feed intake of the rabbits fed with TF was significantly higher ( $P<0.05$ ) than those fed with HMF, while those fed with OMF had no significant difference ( $P>0.05$ ) with the other types of feeders.

Numerically, intake is generally higher with the HMF types.

### 3.2.2 Weekly weight gain of grower rabbits fed with OMF, TF and HMF types

In Table 6, the weight gain of grower rabbits fed with three feeder types was presented. The results show that there is no significant difference ( $P>0.05$ ) in the weight gain of the grower rabbits across the three treatments.

### 3.2.3 Weekly feed conversion ratio of grower rabbits fed with OMF, TF and HMF types

Table 7 shows the feed conversion ratio of grower rabbits fed with three types of feeders (OMF, TF and HMF). The results of the experiment show that no significant difference ( $P>0.05$ ) was observed among the three treatments. This observation was similar throughout the four weeks that the experiment lasted.

**Table 1. Weekly feed intake of weaner rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)	SEM
Week 1	591.50 <sup>a</sup>	462.00 <sup>b</sup>	488.25 <sup>b</sup>	34.927
Week 2	684.25	651	640.50	22.592
Week 3	764.75	712.25	707.00	27.414
Week 4	917	820.75	789.25	56.000

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P<0.05$ )

**Table 2. Weekly weight gain of weaner rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)	SEM
Week 1	200.00	214.00	168.50	22.213
Week 2	129.50	105.25	119.75	23.994
Week 3	75.75	65.75	97.50	16.494
Week 4	78.25	90.25	51.25	6.000

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P<0.05$ )

**Table 3. Weekly feed conversion ratio (FCR) of Weaner rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)	SEM
Week 1	2.96	2.16	3.06	0.503
Week 2	5.28	6.19	6.26	1.553
Week 3	10.10	10.83	7.93	1.375
Week 4	11.72	9.09	15.92	0.077

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P<0.05$ )

**Table 4. Weekly feed wastage of weaner rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)
Week 1	284.50 <sup>a</sup>	378.00 <sup>b</sup>	351.75 <sup>b</sup>
Week 2	155.75	189.00	199.50
Week 3	75.25	125.75	133.00
Week 4	133.00	229.25	260.75

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P<0.05$ )

**Table 5. Weekly feed intake of grower rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)	SEM
Week 1	759.50	806.75	736.75	34.927
Week 2	750.75 <sup>b</sup>	810.25 <sup>a</sup>	761.25 <sup>ab</sup>	22.592
Week 3	757.75 <sup>ab</sup>	803.25 <sup>a</sup>	722.75 <sup>b</sup>	27.410
Week 4	920.5 <sup>a</sup>	992.25 <sup>ab</sup>	923.75 <sup>b</sup>	23.218

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P<0.05$ )

**Table 6. Weekly weight gain of grower rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)	SEM
Week 1	52.50	70.75	47.50	22.212
Week 2	135.00	140.00	165.00	23.994
Week 3	81.00	125.00	125.00	16.495
Week 4	93	83	176	24.338

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P < 0.05$ )

**Table 7. Weekly feed conversion ratio of grower rabbits fed with OMF, TF and HMF types**

	OMF (g)	TF (g)	HMF (g)	SEM
Week 1	14.46	11.40	15.51	0.235
Week 2	5.56	5.79	4.61	1.634
Week 3	9.35	6.43	5.78	1.533
Week 4	9.90	11.95	5.28	1.812

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P < 0.05$ )

### 3.2.4 Weekly feed wastage of grower rabbits fed with OMF, TF and HMF types

Table 8 shows the feed wastage of grower rabbits across the three feeder types. The results show that in the first and the last week, there was no significant difference across the treatments. However, the wastage recorded in the rabbits fed with the OMF (89.25) was significantly higher ( $P < 0.05$ ) than those fed with the HMF (78.75), which was also significantly higher ( $P < 0.05$ ) than the TF (29.75) in the second week. A similar observation was made in the third week where the wastage in the HMF (117.25) was significantly higher ( $P < 0.05$ ) than the OMF (82.25), which was also significantly higher ( $P < 0.05$ ) than the TF (36.75).

## 4. DISCUSSION

### 4.1 Performance of Rabbits Fed with Three Different Feeder Types

Feed intake of the weaner rabbits was significantly higher when the rabbits were fed with the OMF compared to the HMF and TF in the first week, this could be as a result of adaption from the dam during nursing, to the OMF types which is generally used. However, in the grower rabbits, feed intake in the second and third week was significantly higher ( $P < 0.05$ ) in rabbits fed with TF than those fed with OMF, this corresponds with the work of [13] where it was observed that cylindrical-metallic tin feeder may enhance feed intake compared to the Chinese bamboo and the J-feeders. Grower rabbits properly adapted faster to the new feeders (HMF

and TF), reason why no significant difference was recorded in the first week and results in the subsequent weeks proved this observation further. In both the weaner rabbits and the grower rabbits, there was no statistical difference ( $P > 0.05$ ) observed throughout the experiment on the weight gain of the rabbits fed with the three feeder types. This is in line with the study of [13], which reported that live weight of the animals was not significantly affected by feeder type but by cage density.

The results of the experiment show that no significant difference ( $P > 0.05$ ) in the FCR was observed among the three treatments (OMF, TF and HMF). This observation was similar throughout the four weeks that the experiment lasted; and in both weaner and grower rabbits. FCR is the most extensively used parameter for estimation of feed efficiency in intensive systems [14]. The high FCR may be due partly to the use of less energy dense diets during this study; this could also be due to the low fibre content in the diet. Also, environmental conditions affect the FCR because of their effect on the requirements for thermoregulation, the amount of feed eaten at each meal decreases with higher temperature [15]. During the summer, a more favourable FCR is obtained than during the winter despite the lower growth rate. On the other hand, at low temperature (winter) higher growth rates but also a higher FCR is observed compared to the fattening when heat stress occurs [16]. Feeding wastage due to the feeder design has also been shown to have a significant impact on the FCR of rabbits, but that the number of places at a feeder for a group of rabbits did not influence daily feed intake [15].

**Table 8. Feed wastage of grower rabbits fed with hollow, open and tin feeder types**

	OMF (g)	TF (g)	HMF (g)
Week 1	80.50	33.25	103.25
Week 2	89.25 <sup>a</sup>	29.75 <sup>b</sup>	78.75 <sup>ab</sup>
Week 3	82.25 <sup>a</sup>	36.75 <sup>b</sup>	117.25 <sup>ab</sup>
Week 4	129.50 <sup>b</sup>	57.75 <sup>ab</sup>	117.25 <sup>a</sup>

<sup>ab</sup> Means in the same row with different superscripts are significantly different ( $P < 0.05$ )

#### 4.2 Feed Wastage of Rabbits Fed with Three Different Feeder Types

In practice, feed wasted during feeding by rabbit is not recovered and cannot be fed to the animals because of faecal and urine contamination. This implies that the more feed wasted from a given feeder type, the more money the farmer loses and the higher the production cost. In weaner rabbits, the feed wastage by the rabbits fed with the OMF was significantly lower ( $P < 0.05$ ) than the HMF and TF during the first week, and according to the work of [13], the type of feeder had no significant ( $P > 0.05$ ) effect on feed intake, growth rate, feed conversion efficiency or mortality rate but feed wastage was significantly ( $P < 0.01$ ) affected by feeder type and was greatest with the metallic J-feeder. In subsequent weeks, the wastage was numerically lower in rabbits fed with OMF types than TF and HMF, this could be as a result of acclimation to the type of feeder. In grower rabbits, the wastage recorded in the rabbits fed with the HMF was significantly higher ( $P < 0.05$ ) than those fed with the OMF, which was also significantly higher ( $P < 0.05$ ) than the TF. This could be due to smaller size of the entrance of the feeder. This implies that the OMF is a good choice of rabbit feeder design for both weaner and grower rabbits but with a higher Feed Conversion Ratio.

#### 5. CONCLUSION

The results of this study showed HMF type is generally not a good choice of rabbit feeder design for both weaner and grower rabbits. Therefore, as a replacement, the OMF type can be adopted for the weaner rabbits while the TF type can be adopted for the grower rabbits.

It is recommended that the effect of these feeders (OMF, TF and HMF) should also be studied in matured male rabbits, matured female rabbits, pregnant and nursing does.

#### ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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