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Effect of High Fibre Diets on the Post-weaning Growth Performance of Rabbits

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ABSTRACT

This study was conducted to determine the effect of high-fibre diets on the post-weaning growth performance of rabbits. In an eight-week experiment, rabbits were placed on three dietary treatments containing different fibre levels of 14%, 16% and 18% representing T1, T2 and T3 respectively. Each treatment had six replications. The experiment was blocked according to weight. The parameters measured were total feed intake (TFI), average daily feed intake (ADFI), average weekly feed intake (AWFI), average weight gain (AWG), average daily gain (ADG), average weekly weight gain (AWWG), feed conversion ratio (FCR) and mortality. The results showed that the rabbits on the 14% CF diet had the highest ($p < 0.05$) TFI, ADFI, AWFI, AWG, ADG and AWWG, compared to those on the 16% and 18% CF diets; however, those on the 16% CF diet performed better than those on the 18% CF diets in these parameters. There were no significant differences in the FCR between the treatments ($p > 0.05$). The results of this study show that rabbits do not perform well when dietary fibre levels are increased above 14% and thus, for commercial production, rabbit feed should be formulated with a fibre level of 14%.

Keywords: *Dietary fibre, gut, feed intake, weight gain, feed conversion ratio*

INTRODUCTION

The global demand for animal protein has been consistently rising, particularly evident in developing regions like sub-Saharan Africa. This surge in the requirement for animal protein is a consequence of both the continuous expansion of the global human population, and the recognition of animal protein's essential role in human development and overall well-being (Alexander et al., 2015). The rise in demand for animal-based protein sources has been propelled by factors such as increased economic status, urbanization, and industrialization, especially within developing nations (Karikari et al., 2011). Various strategies have been employed to address this mounting demand, incorporating enhanced management and production techniques, refined nutritional practices, efficient utilization of genetic resources and agro-industrial by-products, and the promotion of non-commercial or backyard animal production (Onifade & Tewe, 2010).

While cattle, sheep, and goats are commonly sought-after sources of animal protein, their long gestation cycles, and other factors hinder them from adequately bridging the protein deficit (Adeyemo et al., 2014). The study of De Blas et al. (2019) highlights the increasing focus on nutritional approaches that optimize animal growth while addressing sustainability and animal welfare concerns. Rabbits, as unconventional livestock, are renowned for their prolificacy and research utility. They serve as an excellent source of nutritious, low-fat, low-cholesterol meat, efficiently utilizing plant protein and converting fodder to high-quality animal protein (Abdolghafour & Saghir, 2014**)**. Rabbit production entails low capital investment, offers profitability due to rapid growth rates and adaptability, and has led to the development of various breeds with valuable traits (Abu et al., 2008; Egna et al., 2012). Rabbit meat's nutritional attributes, including taste, low-fat content, and reduced sodium and cholesterol levels (Pote et al., 2009), position it competitively in the meat market, hence generating substantial returns for producers.

In rabbits, the post-weaning phase is a critical time when they switch from consuming maternal milk to solid feed. During this phase, diet composition significantly influences growth trajectory and overall health. Incorporating high-fibre diets has garnered attention due to their potential to stimulate growth, enhance gut health, and improve nutrient utilization (De Blas *et al*, 2019). The bulkiness of fibrous feeds stimulates gut motility and can increase nutrient utilization, although the impact on weight gain can be variable (Adesogan, 2019). Rabbits' unique digestive system, reliant on hindgut fermentation, often results in higher fibre digestibility compared to other animals (Samanta, 2013). High-fibre diets foster healthy gut microbiota, optimizing fibre fermentation and influencing growth performance. Nonetheless, maintaining the proper balance of fibre types and other dietary components is crucial for optimal gut function (Combes *et al*., 2013).

The objective of this study, therefore, was to examine the post-weaning growth performance of rabbits fed diets containing different levels of fibre.

MATERIALS AND METHODS

Experimental site

The study was carried out at the Dairy/Beef Cattle Research Station, Kwame Nkrumah University of Science and Technology (KNUST). The location falls within Ghana's semi-deciduous humid forest zone at coordinates 06°43'N and 01°36'W. The zone is recognized for its bimodal rainfall distribution, with an annual precipitation of approximately 1300mm. The principal rainy season spans from March to July, while a minor rainy season persists from late August to October. The dry harmattan season starts from November through February. Throughout the year, the daily temperatures fluctuate between 18°C and 35°C, averaging around 26°C. Relative humidity ranges from 97% during the early morning in the wet season to as low as 20% during the late afternoon in the dry season. The typical photoperiod spans 12 hours.

Experimental units and duration

In this experiment, the Californian white breed of rabbits common in Ghana were used. A total of 18 weaner rabbits (weaned at 6 weeks old) were selected from a herd maintained at Boadi Cattle Research Station. The experiment was conducted for 8 weeks.

Experimental design and diet

The rabbits were assigned to three dietary treatments, according to a randomized complete block design. Each of the three blocks had 6 rabbits housed individually, and the blocking was done according to body weight (body weight ranged from 437g to 836g for T1, 387g – 818g for T2, and 442g – 694g for T3; with averages of 654.3g, 604.3g and 584g respectively). The three dietary treatments were: (1) concentrate containing 14% crude fibre (T1), (2) concentrate containing 16% crude fibre (T2), and (3) concentrate containing 18% crude fibre (T3). Each treatment had 6 replicates, two in each block. The rabbits were managed under the intensive system with rabbits housed in individual cages in raised hutches made of metallic material.

Feed formulation

The concentrate feeds were formulated according to NRC (1977) recommendations using Microsoft excel solver and were compounded at the Dairy/Beef Cattle Research Station, KNUST (Table 1).

Table 1. Ingredient composition of the experimental diets

INGREDIENTS (g)	T1 (14% CF)	T2 (16% CF)	T3 (18% CF)
Wheat bran	30	21.50	0
Rice bran	0	30	25.91
Ground maize	13.43	3.27	8.01
Soybean meal	14.15	0	0
Palm kernel cake	31.01	9.24	25.18
Copra cake	10.41	34.64	39.66
Dicalcium phosphate	0.5	0.85	0.74
Salt	0.25	0.25	0.25
Premix	0.25	0.25	0.25

Proximate analysis

The proximate composition of the experimental diets (dry matter, moisture content, ash, crude fat, crude fibre, crude protein, and nitrogen-free extract) were determined at the Nutrition Laboratory in the Department of Animal Science, KNUST, according to the procedure of AOAC (1990). The metabolizable energy was calculated using the formula below:

Metabolizable energy (ME) = (37 × protein) + (81.8 ×fat) + (35 × nitrogen-free extract)

Feeding

The rabbits in each block , were fed 150g of the ration (T1, T2, and T3 respectively) daily. The rabbits were provided fresh water every morning during the experiment. The feeding trial lasted for 8 weeks, and the first week served as an adaptation period.

Data collection

The parameters measured were;

- Total feed intake(g) = Feed allowed(g) – Leftover(g)
- Average daily feed intake (ADFI) $= \frac{Total\ feed\ intake}{\text{Number of days}}$ (g/d)
- Average weekly feed intake (AWFI) $= \frac{\text{Total feed intake}}{\text{Number of weeks}}$ (g/wk)
- Weight gain(g) = Final weight – Initial weight

- Average weight gain (AWG) $= \frac{\text{Weight gain}}{\text{Number of rabbits}}$ (g)
- Average daily gain (ADG) $= \frac{\text{Weight gain}}{\textit{Number of days}}$ (g/d)
- Average weekly weight gain (AWWG) $= \frac{\textit{Weight gain}}{\text{Number of weeks}}$ (g/wk)
- Feed conversion ratio (FCR) $= \frac{\textit{Feed consumed (g)}}{\textit{Mean weight gain (g)}}$

Data were collected daily for feed intake, and the weight of the rabbits was taken weekly, from the first to the final week.

Statistical analysis

Data were subjected to one-way analysis of variance (ANOVA) with blocking, using the Linear Model of Statistix 8.0 software. Differences between treatment means were detected using Tukey's HSD test. Significant differences between means were set at p < 0.05.

RESULTS AND DISCUSSION

Proximate analysis

Observations made from Table 2 show that as the fibre level increased, there was an increase in dry matter and crude fat content. Conversely, higher fibre levels led to a decrease in moisture, crude protein, and NFE content. Among the diets, the one with 18% CF had the highest metabolizable energy, while the 16% CF diet had the least. Additionally, the 16% CF diet had the highest ash content, whereas the 14% CF diet exhibited the lowest (Table 2).

Table 2. Proximate analysis of dietary treatments (from week 6 to week 12)

PARAMETERS ON AS-FED BASIS	14% CF	16% CF	18% CF
Dry matter (%)	91.2	91.4	92.2
Moisture content (%)	8.8	8.6	7.8
Ash (%)	4.3	8.3	6.6
Crude fat (%)	4.2	8.0	8.4
Crude fibre (%)	14.2	16.1	18.4
Crude protein (%)	16.2	15.9	15.8
Nitrogen-free extract (%)	52.3	43.1	43.0
Metabolizable energy (kcal/kg)	2773.5	2751.2	2776.7

Growth performance

Initial weight

There were similarities between the initial weights of the rabbits across all treatments (p>0.05).

Feed intake

The rabbits fed the 14% CF diet recorded the highest total feed intake, with the lowest recorded in rabbits on the 18% CF diet. The lower total feed intake for the 16% and 18% CF diets may be attributed to their higher fat content. This observation aligns with the findings of Gidenne (2005), who noted that the inclusion of fat leads to a marginal decrease in feed consumption (Table 3).

Alternatively, the lower feed intake could also be attributed to the increased fibre levels (Gidenne, 2015b). However, Wafer et al. (2019) and Houndonougbo (2015) reported an increase in feed intake when rabbits were fed diets containing higher fibre levels.

Final weight and weight gain

The rabbits fed the 14% CF diet exhibited higher weight gain compared to those on the 16% and 18% CF diets (Table 3). This discrepancy is likely attributed to the fibre content present. Gidenne (2015a) reported that as fibre levels increase, the rabbit cannot increase its intake sufficiently to meet its energy requirement, thus leading to a lower growth rate. The lower weight gain might have also stemmed from digestive disorders, as many rabbits on the 14% and 16% CF diets displayed signs of diarrhoea. Gidenne (2015b) in a review, underlines how digestive disorders manifest as growth depression and compromised feed efficiency. Gidenne et al. (2004) similarly attributed all digestive disorders to fibre levels, while Wafer *et al*. (2019) documented poor weight gain at higher fibre concentrations.

Farias-Kovac et al. (2020a) in agreement, also stated that rabbits tend to exhibit slower growth as fibre increases. This is because the retention efficiency of the digestible energy which is used for growth is impaired. However, this is in contrast with the findings of Xiccato et al. (2011) and Gidenne et al. (2013), who reported that replacing protein with fibre led to a significant improvement in the digestive health status of growing rabbits, without any significant impairment in growth performance. This disparity could be attributed to the focus of their research on digestible fibre, while neglecting the presence and effect of indigestible fibre fractions.

Table 3. The effect of high fibre diets on the post-weaning growth performance of rabbits

PARAMETERS	14% CF	16% CF	18% CF	P VALUES	SEM
Initial WT (g)	654.3[a]	604.3[a]	584.0[a]	0.7124	61.4
TFI(g)	2243.3[a]	1990.5[ab]	1371.8[b]	00395	258.9
ADFI (g)	53.4[a]	47.4[ab]	32.7[b]	0.0395	6.1
AWFI (g)	373.9[a]	331.8[ab]	228.6[b]	0.0395	43.2
FINAL WT (g)	1106.3[a]	734.8[b]	680[b]	0.0011	93.66
AWG (g)	452.0[a]	130.5[b]	96.0[b]	0.0004	113.4
ADG (g/d)	10.8[a]	3.1[b]	2.3[b]	0.0004	2.7
AWWG (g)	75.3[a]	21.8[ab]	16.0[b]	0.0004	18.9
FCR	5.0[a]	15.3[ab]	14.3[b]	0.1058	3.3
Mortality (%)	5.6[a]	0[a]	11.1[a]	0.2500	0.2357

*a,b = mean values across the table with different superscripts are significantly different($p<0.05$). TFI - total feed intake, ADFI - average daily feed Intake, AWFI - average weekly feed intake, AWG - average weight gain, ADG - average daily gain, AWWG - average weekly weight gain, FCR - feed conversion ratio.

Feed conversion ratio

Rabbits fed with the 14% CF diet demonstrated enhanced feed conversion ratios compared to those fed with the 16% and 18% CF diets (Table 3). Recent research focusing on the effects of dietary

CF content on rabbit performance provides valuable insights into elucidating this FCR discrepancy. The favourable FCR observed among rabbits on the 14% CF diet could be attributed to the well-balanced nutrient composition of the diet.

The optimal CF content of the 14% CF diet potentially contributes to a more efficient utilization of nutrients by supporting both gastrointestinal health and nutrient absorption. Gidenne & Pinheiro (2016) agrees that the optimal level of dietary fibre likely promotes a moderate rate of passage through the digestive tract, facilitating thorough fermentation and nutrient absorption. Consequently, this process leads to an enhancement in feed conversion ratio. Furthermore, the positive influence of the 14% CF diet on FCR could be attributed to its impact on the gut microbiota.

Xiccato *et al*. (2011) have underscored the role of dietary fibre in shaping the composition of the gut microbiota, a pivotal player in nutrient metabolism and overall health. The 14% CF diet may be fostering a beneficial microbial environment that augments the digestion and absorption of nutrients, ultimately contributing to the observed higher FCR. In addition, the 14% CF diet could ameliorate potential digestive disturbances that might arise from excessive fibre intake, as reported by Gidenne (2015a). Other factors, like gut motility concerns and nutrient imbalances, can detrimentally impact feed utilization and growth performance, and could be a reason for the less favourable FCR values observed in rabbits fed with the 16% and 18% CF diets. A similar observation was made by Wafer *et al.*, 2019 who recorded poor feed conversion ratios at higher fibre levels.

Mortality rate

The different levels of fibre employed in this study had no effect ($p < 0.05$) on mortality. In agreement, Farias-Kovac *et al*. (2020b), in their study to evaluate the effect of increasing the soluble and insoluble fibre fractions reported that, high levels of fibre had no effect on mortality.

CONCLUSION

It can be concluded that including 14% crude fibre (CF) in the diet enhances the growth performance of rabbits after weaning. Elevating the fibre level in the diet of weaner rabbits beyond 14% diminishes the growth performance of post-weaned rabbits.

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COMPETING INTEREST

The authors declare no conflict of interest in the publication of this article.

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