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Research Paper

Nutrients Intake, Utilization and Performance of Grasscutters (*Thryonomys swinderianus*) fed *Pennisetum purpureum* as Basal Feed Supplemented with Concentrate Feeding Regimes

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ABSTRACT
Fifty grasscutters (Thryonomys swinderianus) were used for a study using a completely randomized design to determine the nutrients intake, utilization and performance fed elephant grass (Pennisetum purpureum) as basal feed. The treatments were T_1, T_2, T_3, T_4 and T_5 for 1, 3, 5, 7 and 9% respectively representing the quantity of concentrate feed which were served at their % weekly live weight. Each treatment replicated 5 times with 2 animals of each replication. Parameters were performance traits, energy intake, protein intake, protein efficiency ratio, mortality and proximate analysis. Results showed that the parameters measured were significantly difference among the feeding regimes. The concentrate intake highest (89.08 g) was T_5 while the lowest (10.16 g) was T_1. The forage intake was highest (245.30 g) T_1 and lowest (205.32 g) T_4. The weight gain was highest (15.93 g) at T_3 and lowest (4.77 g) at T_1. The worst FCR (forage) was in T_1 (55.22) and the best was in T_3 (13.23). Concentrate worst FCR was in T_5 (8.77) and the best in T_1 (2.42). The energy intake highest (3.48) T_5 and (2.82) T_1 lowest. The protein intake 17.56 was highest in T_5 and lowest 12.25 in T_1. EER (0.66) T_3 highest and 0.24 T_1 lowest. PER highest 0.97 T_3, lowest (0.39) T_1. Mortality wasn't found in all treatments. Proximate, formulated diet was 17.85% CP similar to calculated value 18% CP, CF (5.07%) and EE (3.20%). Elephant grass had (9.25%) CP, CF (31.00%) and EE (1.17%). It was concluded that 5% level of concentrate feed supplement using elephant grass as basal feed should be used in rearing grasscutters.
KEYWORDS: *concentrate, nutrients intake, grasscutters, supplementation Regimes, weight gain*

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I. INTRODUCTION

The animal industry plays a very vital role in any country in meeting the protein requirements of the population [1]. The current rate of population growth indicates that the world population might hit 9 billion by the year 2040 of which developing countries are considered the most populous [2]. Therefore, it needs improving to produce enough to feed [3]. Low-cost foods rich in good-quality protein are scant in Nigeria, which makes it difficult to meet protein requirements [4]. It has been observed that the average protein availability to the area (such as Kwara State) is below the minimum per capita requirement despite the fact that rural households are the major producers of food [5]. The importance of adequate protein intake (in terms of quality and quantity) in the nutrition of man cannot be over emphasized particularly in these challenging global times due to adequate nutrient intake is an indispensable factor for good health economic advancement of any nation [6].

So there is need to attempt to bridge and sustain this animal protein gap for Nigerians to attain the FAO recommended daily animal protein intake of 35 g and also to try to reduce this under-five death which is commonly experienced among Nigerians. This can be avoided or reduced due to animal source foods provide essential micronutrients and high-quality protein for human diet [7]. This animal protein source should not only be available but affordable to the populace since poverty is not only tied to malnutrition but also to under-nutrition [8]. In attempt to reduce this situation, efforts aimed at increasing diversity in meals are important [9]. Therefore, the use of wild animals that is potentially acceptable, tractable and prolific such as grasscutter (*Thryonomys swinderianus*), is needed [10]. The urgent need to encourage micro or mini-livestock (grasscutter) as a strategy for food security is important since micro or mini-livestock animals means a small amount of input

per unit, which in turn means more flexible production [11], [12]. Mini-livestock farming can be practiced with other occupations [13], the integrated crop–livestock is a base to improve the sustainability of agriculture [14].

Grasscutter production provides an opportunity of supplementing animal protein and income to Nigerians [15]. The grasscutter can be reared with minimal capital outlay and land. It is less affected by disease, devoid of noise and its food requirements are low in captivity. It can therefore serve as a considerable income earner for the small scale urban and rural mini-livestock producers. Grasscutter is desirable for domestication because of its excellent taste, acceptability, comparatively high nutritional value and meat yield than most species of livestock [16].

[17] suggested that efficient production in captivity of grasscutter with high productivity required adequate nutrition. The level of nutrition does not only affects the growth of animals but the composition of their meats. [18] reported that though grasscutters are herbivorous animals and they can grow rapidly on compounded feeds. The domestication of grasscutter in terms of nutrient requirements have not yet been perfectly established but when confined, should be fed with forages and concentrate. It was also suggested that captive reared grasscutter should be fed with forages and concentrates depending on the availability of the feed source, but the concentrates must be in low quantity to avoid a negative influence on the animal [19].

The gastro-intestinal tract of grasscutter combines the functions of the monogastric and ruminant digestive tracts [20]. It is suggested that the grasscutter would require the same 41 nutrients ordinarily required by other monogastric animals, non-essential which can be synthesized by the body system enough to meet up the dietary requirements and 13 essential amino acids which cannot be synthesized enough by the body system. These consist of arginine, cysteine, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, tyrosine, and valine [20]. They added that, grasscutters gastro-intestinal tract is adapted to handle high fibre materials because of the presence of a large caecum which houses some microbes that help in the digestion of cellulose with the presence of cellulolytic bacteria in the caecum.

Elephant grass (*Pennisetum purpureum* Schum) stands out for being perennial and adapted forage to different soils and climate conditions [21]. However, it is rather low in energy and protein, due to its high cell wall content as reported by [22] in their proximate analysis. They added that, elephant grass is very sensitive to climatic conditions, maturity and regrowth days, with a decrease in crude protein content, an increase in fibre, a decrease in dry matter and cell wall, as measured by *in situ* degradability and *in vivo* digestibility. Since at the moment, no baseline nutrient requirements and no particular feeding regime for concentrate have been established for its optimal performance. It was therefore the objective of this research to evaluate the concentrate feeding regime on the nutrients intake, utilization and growth performance of grasscutters using elephant grass as basal feed.

II. MATERIALS AND METHODS

Experimental location

The study was carried out in Obubra, Cross River State. This is located between longitude $8^0$19'10.5"-$8^0$21'06.8" E and latitude $6^0$01'52.0"-$6^0$05'46.8" N of the equator. The mean annual rainfall of the area ranges from 500 to 1,070 mm, with a warm weather and ambient temperature of about 20-30 ^{0}C [23]. Obubra is located along the banks of the Cross River in the Southern Guinea Agro-Ecological Zone of Nigeria. Obubra is about 159 km from Calabar, the State Capital of Cross River State of Nigeria.

Experimental animals and design

A total of fifty (50) weaned grasscutters between the ages of 3-4 months obtained from a local farmer in Ibadan were used for the feeding trial. The grasscutters which were put into groups of similar body initial weight of 725 g were randomly assigned to five treatments feeding regimes in a completely randomized design. There were five replicates in each treatment with two animals serving as a replicate. The animals were given elephant grass as basal feed *ad libitum* and formulated concentrate supplemented at a feeding regime of 1, 3, 5, 7, and 9% for T_1, T_2, T_3, T_4 and T_5 respectively of their % weekly live body weight throughout the period of the experiment that lasted for 20 weeks.

Housing and experimental procedure.

The grasscutters were individually housed in clearly and properly-labelled concrete cells measuring 90 x 75 x 40 cm (length x width x height). There was an opening only at the top in order to eliminate cross-ventilation and prevent the adverse effect of cold, because grasscutters are very susceptible to pneumonia. The top was partly covered to create a darken area meant for hiding which is their habit. Each cell was provided with a feeder and a drinker. The cemented cells were constructed in a well-ventilated cement block walled house roofed with asbestos sheets to protect the animals from bad environmental conditions such as rainfall and cold conditions.

On introduction into the cells, the animals were provided with anti-stress agent vitalyte in drinking water. They were also dewormed using piperazine and given 5 gm each of cocciodiostat agent. Elephant grass (*Pennisetum purpureum*) were cut and allowed to wilt for about 12 hours, weighed and fed daily as basal diet. Water and elephant grass were supplied *ad libitum*. The animals were weighed weekly throughout the period of 20 weeks of the study. All cells were cleaned daily in order to ensure an adequate level of sanitation.

Experimental diet

A concentrate supplement diet was formulated to contain approximately 18% crude protein and a Metabolizable energy of 2961.47 kcal kg^{-1} (Table 1) was used at different feeding regimes of 1, 3, 5, 7 and 9% of their weekly body live weight and fed with wilted elephant grass as basal feed.

Table 1. Composition of concentrate feed and calculated values of experimental diets

Ingredients	Percentage (%)
Maize	58.41
Soybean meal	27.59
Rice offal	10.00
Bone meal	3.00
Vitamin-min-premix*	0.50
Common salt	0.50
Total	100.00
Calculated nutrients composition.	
Crude Protein	18.00
Metabolizable Energy ($kcal^{-1}kg^{-1}$)	2,961.47
Crude fibre (%)	6.97
Calcium (%)	1.16
Phosphorus (%)	0.89

Note: * Each 1kg of vitamin/mineral premix manufactured by BEAUTS Co. Inc. Man, U.S.A., contains Vitamin A 220,000, Vitamin D 66,000, Vitamin E 44, 014; Vitamin K 88 mg; Vitamin B 12; 0.76 mg; Niacin 1122 mg, Calcium 27%, Phosphorus 10%, Iron 0.6%, Zinc 0.35%, manganese 0.25%, Copper 0.06%; Iodine 0.002%, Cobalt 26 ppm, Selenium 4 pp. ME = Metabolizable Energy

Data collection/parameter measured

Feed intake (FI)

A weighed quantity of elephant grass was offered *ad-libitum* to each grasscutter and the remnants from the grasses provided was weighed and the difference obtained was recorded for daily forage intake while concentrate supplement was calculated based on each grasscutter's % weekly live body weight and given to them daily and the left-over feed weight was recorded for their daily concentrate intake.

Weight gain (WG)

The grasscutters were weighed at the beginning of the experiment and weekly thereafter, the average daily weight gain was obtained by dividing the mean weekly weight gain by seven (7). Weighing of the animals were normally done before morning feeding at 7.30 am.

Feed conversion ratio (FCR)

The efficiency with which each animal converted feed to body weight was computed as a ratio of the average daily feed consumed to the average daily weight gained (gram of feed : gram of gain).

$$\text{Feed to gain ratio} = \frac{\text{Daily feed intake (g)}}{\text{Daily weight gain (g)}}$$

Energy Efficiency Ratio (EER)

This was determined as the ratio of gain in body weight to the energy consumed.

$$\text{EER} = \frac{\text{Gain in body weight (g)}}{\text{Energy consumed (g)}}$$

Protein Efficiency Ratio (PER)

This was determined as a ratio of gain in body weight to the protein consumed.

$$\text{PER} = \frac{\text{Gain in body weight (g)}}{\text{Protein consumed (g)}}$$

Mortality records

Records of mortality were kept throughout the experimental period.

Chemical assay
The proximate content of the diet and elephant grass were determined according to the procedures outlined by [24].

Experimental design and data analysis
A completely randomized design was used for the study. Data collected were subjected to analysis of variance (ANOVA) using Minitab V16 statistical software, where means were significant, there were separated at 5% significant level of probability using least significant difference according to the procedures contained in the software.

III. RESULTS AND DISCUSSION

Proximate composition of the concentrate feed supplement and elephant grass

The results of the proximate composition of the formulated diet and elephant grass used for the study is presented in Tables 2. The crude protein content of the experimental diet analysed (17.85%) was similar to the calculated value (18%) and met the crude protein requirements of growing grasscutters (18%) [25]. Elephant grass has low protein content of 9.25%, high fibre content of 31.00% and ether extract content of 1.17%, thus necessitating the use of formulated concentrate so as to improve their performance. The results of proximate analysis is similar to that of [26] and [27] with some few variations may be due to soil nutrients or period of harvest since these factors among others are known to affect the nutrients availability of forages.

Table 2. Proximate composition of elephant grass and concentrate supplement

Constituents	Dry matter	Crude protein	Crude fibre	Ether extract	Ash	NFE	MEkcal^{-1}kg^{-1}
Elephant grass % composition	34.30	9.25	31.00	1.17	9.28	49.30	2187.17
Concentrate % composition	86.98	17.85	5.07	3.20	10.12	50.74	2720.92

Note: NFE = Nitrogen free extractives

Effect of elephant grass and concentrate supplement regimes on the growth of grasscutters

The results of the effect of elephant grass and concentrate supplement regimes on the growth of grasscutter is presented in Table 3. The average daily intake of concentrate supplemented diets was highest (89.08 g) for grasscutters on T_5 though did not differ ($P>0.05$) from T_3 and T_4 and lowest (10.16 g) for grasscutters on T_1. Intake of concentrate supplemented diet was significantly ($P<0.05$) different among the treatments. The daily intake of supplemented diets was significantly ($P<0.05$) affected by the percentages of the feeding regimes and increases from the lowest percentage (1%) to the highest (9%) concentrate intake which followed a particular trend, it increases vis-à-vis the level of percentage increase. Generally, the concentrate intake recorded in this study was less than the range of values reported by [27], 178.02- 262.05 g.

Table 3. Performance characteristics of grower grasscutter fed concentrate supplement regimes

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Av. Initial wt (g)	726	728	725	723	725	-
Av. Final wt (g)	1392.50^{c}	2042.50^{b}	2910.00^{a}	2657.50^{a}	2335.00^{ab}	206.10
Av. Total wt Gain (g)	667.50^{c}	1317.50^{b}	2185^{a}	1932.50^{a}	1610.00^{ab}	197.47
Av, Daily wt gain (g)	4.77^{d}	9.23^{c}	15.93^{a}	13.72^{ab}	11.45^{bc}	1.39
Av. Daily Feed Intake Forage (g)	245.30^{a}	218.08^{b}	210.58^{b}	205.32^{b}	207.78^{b}	5.61
Av. Daily Feed Intake Conc. (g)	10.16^{c}	39.40^{b}	75.28^{a}	75.41^{a}	89.08^{a}	7.81
Feed conversion Ratio, Forage	55.22^{a}	24.34^{b}	13.23^{b}	16.05^{b}	19.50^{b}	5.12
Feed conversion Ratio, conc.	2.42^{c}	4.28b^{c}	4.73^{bc}	5.77^{ab}	8.27^{a}	0.94
Energy Intake (kcal/Head/day)	2.82^{b}	2.92^{b}	3.32^{a}	3.27^{a}	3.48^{a}	0.13
Protein Intake (g/Head/day)	12.25^{b}	13.60^{b}	16.46^{a}	16.23^{a}	17.56^{a}	0.99
Energy Efficiency Ratio (kcal/wt. gain)	0.24^{a}	0.45^{b}	0.66^{c}	0.59^{b}	0.46^{b}	0.87
Protein Efficiency Ratio Mortality	0.39^{c}	0,68^{b}	0.97^{a}	0.85^{a}	0.65^{b}	0.09

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	0.00	0.00	0.00	0.00	0.00	0.00

Note: a, b and c means within rows with similar superscripts are not significantly different (p>0.05), SEM= Standard Error of mean, AV. = Average, Wt = weight, Conc.= Concentrate

The daily forage intake was also significantly (P<0.05) different among the treatments with the highest intake (245.30 g) for grasscutters on elephant grass and 1% concentrate supplement and the lowest (205.32 g) intake for grasscutters on T_4 with 7% concentrate supplement. It was observed that the daily forage intake did not follow any particular trend that could be attributed to the forage individual preference by the grasscutters. The daily forage intake was lower than those recorded by [27] which ranged from 371.14-400.40 g when they fed them with varying dietary protein levels using elephant grass as basal feed. This forage intake in T_1 in this study contradicted the findings of [28] when they submitted that grasscutters fed with whole guinea grass had lower feed intake compared to those fed with the leaf part only. This however, may be connected with [29] who reported that some physical characteristics of the forage, such as dry matter content and particle size are known to affect ease of prehension and thus intake rate and also supported by [30] who stated that the crude fibre and crude protein levels of the diet may limit feed intake which may not be applicable to this study. [31] informed that lower metabolizable energy could also lead to increase in feed intake which may also be attributed to this study since the metabolizable content of forage was as low as 2,187.17 kcal kg^{-1} which led to more forage intake to meet up their dietary energy requirement. This is in line with the observation made by [32] who reported that, changes in dietary energy concentration modulate feed efficiency; firstly, as dietary energy increases, energy needs are satisfied with decrease feed intake, and secondly growth rate is promoted by increasing dietary level of energy.

Several authors have reported different values for total weight gain of grasscutters. [27] reported value range of 650-850 g when the grasscutters were fed varying levels of dietary protein on growth performance. [28] reported values that ranged from 225-625 g as total weight gain for grasscutters at the end of an experiment that lasted for 24 weeks. In another study by [33] where performance of grasscutters were assessed when fed four different conventional forages, the total weight gain reported were between 1024 and 1121 g. [34] reported values range of 650-1,190 g as total weight gain for grasscutters fed concentrate diets containing varying level of guinea grass. [35] reported 993.14-1,182.72 g when they fed elephant grass as basal feed and a mixed feeding regime with crude protein of 24% and metabolizable energy of 2340 kcal kg^{-1}. [22] reported 528.08-532 g when they assessed elephant grass, Gambia grass and their fractions using concentrate supplement of 16% and metabolizable energy of 2,500 kcal kg^{-1}. Total weight gains obtained in this study (Table 3) were higher than those reported by these researchers but were only comparable to the T_1 with 1% concentrate supplemented diet. Total weight gain was significantly affected (P<0.05) which agrees with observation made by [22] but differ (p>0.05) from observation made by [35]. These variations may be attributed to the nature of diet and the feeding regime adopted by the various researchers.

Even when the live weight of the grasscutters were equalized among the treatments at the beginning of the trials, the final body weight which ranged from 1392.50 g for grasscutters on elephant grass (1%) concentrate diet to 2910 g for grasscutter on a 5% concentrate supplementation were significantly (P<0.05) different (Table 3).

The average daily body weight gain was also significantly (P<0.05) affected in this study which disagrees with reports by [22] and [35] who had no significant (P>0.05) differences in their studies. The average daily weight gain was highest (15.93 g) for grasscutters on elephant grass at 5% level of concentrate supplement and lowest (4.77 g) for 1% concentrate supplement which also showed a significant effect (P<0.05). This daily weight gain was similar (P>0.05) to the value range reported by [27] 13.27- 15.00 g and higher than 9.41 g and 10.88 g reported by [26] but only similar (P>0.05) to T_3. The average daily weight gains of the grasscutters were significantly (P<0.05) affected by the percentage levels of the feeding regimes, but they were no defined trend in the relationship between average daily weight gains and the feeding regimes.The results however showed that, concentrate supplement feeding of 5% level with elephant grass that had (ADG 15.93 g) was superior to 7% level (ADG, 13.72%) though did not differ significantly (P>0.05). In this T_3, it shows that, the quantity of concentrate supplement was able to combine with low quality roughage to yield the highest daily weight gain. Roughage diets have been shown to aid digestion in cattle [36]. The grasscutters digestive tract includes the well-developed caecum, which fills 60% of the abdominal cavity and functions in such the same way as the four- chambered stomach of cattle. [37] observed that supplementing roughage with protein concentrate enable cattle to increase feed intake hence increased live weight.

As a monogastric herbivore (pseudo-ruminant), the grasscutter is able to use the advantage associated with the efficient utilization of concentrate by monogastric animals. However, it was observed that at the level of 9% concentrate supplementation, the daily weight gain (11.45 g) was inferior to 7% though did not differ significantly (P>0.05) to T_3. It was observed that this 9% level had a negative influence on the daily weight gain, a lower weight gain recorded as against the expectation based on the increased concentrate supplement which cannot in this study be attributed to any fact. This finding however, agrees with the report by [19] who

reported that concentrate can be supplemented to grasscutters feeding but in low quantity so as to avoid a negative influence on the animal. In this study, 1% of their weekly body live weight concentrate supplementation had a very inferior daily weight gain (4.77 g). This could be attributed to the fact that 1% level of concentrate supplementation did not supply adequate nutrients to meet up the dietary requirements of the grasscutters to meet optimal growth and serves slightly above the maintenance diet. It may also be attributed to the high fibre intake in that treatment since most of their feed intake was fibrous in nature, it may have impaired the digestibility of the nutrients and studies have shown that high fibre levels in the diet of grasscutters is associated with poor digestibility of dry matter, proteins and fat which may have led to reduction in growth rate [38].

The feeding regimes on the grasscutters had a significant ($p<0.05$) effect on the feed conversion ratio of both forage and the concentrate supplement. The feed conversion ratio (forage) followed the same pattern of significance ($p<0.05$) like the average daily forage intake, whereas feed conversion ratio (concentrate) did not follow that pattern. The worst FCR (forage) recorded was in T_1 (55.22) and the best was in T_3 (13.23). In the concentrate supplement feeding regimes, the worst FCR was in the group of T_5 (8.77) and the best in T_1 (2.42). This FCR values obtained in this research are better than the values of 543.24, 82.30 and 119.38 reported for grasscutters at the end of a 24 weeks feeding trial [28]. These values are however, higher except for T_1, that had value that ranged from 1.66 - 3.52 [26], and almost similar to the value ranges of 1.81-6.95 Henry and Njume (2008), 4.86-5.04 [33] and 4.8-7.5 [34] for concentrate feeding as reported for grasscutters by various researchers.

The FCR (forage) in this study was also higher than the one reported by [27] whose values ranges from 0.80-0.96. The variations in FCR values may be attributed to the differences in the experimental diets used by different authors and the feeding regimes practiced while carrying out their various experiments.

The energy intake in this feeding trial were significantly affected ($P<0.05$) but the intake did not follow any particular pattern. The highest value was obtained in (T_5) while the lowest was in (T_1) an indication that grasscutters in T_5 had more dietary energy than their counterparts in their diets. This was expected because more concentrate supplement was offered which subsequently led to more intake of the energy.

Protein intake on daily basis increased inconsistently from 12.25 g/animal (diet 1) to 16.46 g grasscutter^{-1} (diet 3) and increased again to 17.56 g/grasscutter (diet 5). Value for the remaining diet was in between. It followed the same pattern of trend like the feed intake. The highest value of protein intake was on diet T_5. This could be attributed to the highest percentage level of concentrate that was offered in that treatment which also led to the highest feed intake by grasscutters may be due to palatability and availability of the concentrate though did not translate to weight gain as expected.

The energy efficiency ratio (EER) in this study was significantly ($P<0.05$) affected by the feeding regime but did not show any pattern of increase. This could be as a result of the individual grasscutter's ability to utilize the diet since efficiency was supposed to increase as the level of dietary energy increases. The highest EER was in diet T_4 while the lowest was in diet T_1. The ECR which is the amount of energy utilized per unit of gain varied between 0.24 (diet 1) to 0.66 (diet 3) and it differed significantly. A particular pattern was not followed, this variation could be attributed to the different energy intake by the various animals.

The protein efficiency ratio PER values varied from (0.39-0.97) and it showed a significant $P<0.05$) different though did not follow any particular pattern. The variation may be due to differences in the crude protein intake among the animals. The highest PER was in T_3 (0.97) while the lowest was in T_1 (0.39). This could be attributed to the fact that, there was more protein intake in treatment three.

In this study, no mortality was recorded throughout the duration of the experimental period of 20 weeks, an indication that 9% level of concentrate supplementation based on the weekly body live weight even though it had a negative effect in terms of growth rate, did not cause any deleterious effect to the grasscutters, neither was there any sign of distress condition among the grasscutters. The absence of mortality could be attributed to the fact that the experimental feeding regime met the dietary requirements of the grasscutters coupled with proper management practices since various factors have been identified to cause mortality, such as, housing (unit space for grasscutters post weaning [39], materials used for constructing grasscutters housing [40]. It could also be that the grasscutters were weaned at the appropriate weaning age since mortality has been reported to be affected by age at weaning [41].

IV. CONCLUSION

The findings of this study suggest that supplementation of forage with formulated concentrate can be an aid in improving the growth performance of grasscutters in captivity but not excess of the concentrate. The performance of the grasscutters at 5% level of concentrate had the best performance which implies that at this level more nutrients were made available which led to the highest growth rate. Based on this finding, it was therefore recommended that, 5% level of concentrate should be used as supplement in improving growth performance of grasscutters using elephant grass as basal feed.

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