The effects of genotype and week of lactation on milk yield, udder dimensions and linear body measurements of non-dairy ewes

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Abstract

One hundred and ninety two records were taken weekly for twenty four (24) weeks from West African Dwarf (WD), the Yankasa (YN) and the West African Dwarf X Yankasa crossbred (XB) sheep. The traits evaluated were milk yield (MK), linear body measurements (LB) such as height at withers, (HT), body length (BL), heart girth (HG), shoulder width (SW), Tail length (TA), Neck length (NL), Neck circumference (NC), Face length (FA), Hind leg length (HL), Foreleg length (FL), Face length (FA), Ear length (EA), Head width (HW) and Rump height (RH) together with the following Udder dimensions (UD): Udder circumference (UC), Teat length (TL) and Teat circumference (TC). There was significant ($P < 0.05$) influence of genotype on MK, WHT, HT, BL, TA, FL, HL, FA, EA and RH. The WD ewes produced more milk than either the YN or XB ewes. Average daily milk yield (ml) was 122.25, 90.88 and 108.8. The YN genotype was superior in all LBs except SW and NC than the WD and XB in the three genotypes. Height at withers was 59.08, 69.21 and 61.81 cm; BL 48.54, 55.08 and 54.49 cm and RH 62.88, 75.11 and 68.46 cm for WD, YN and XB ewes respectively. Since milk offtake is related to body weight and some linear body measurements, selection for WT, HG, SW, NL, NC, UC and TL in WD ewes could lead to higher milk and mutton production.

Keywords: West African Dwarf, Yankasa, Yankasa x West African Dwarf, milk yield, weight, linear body measurement

Introduction

Milk could be an important source of protein especially in Nigeria where per capita consumption is low. There is a growing awareness of sheep as a source of milk for man (Agbede *et al.* 1997; Adewumi *et al.* 2001; 2005). Milk yield which is the quantity of milk produced by lactating ewes is influenced by nutrition, udder size, water, suckling rate and exposure to stress (Nganga *et al.* 1990; Al Jassim *et al.* 1999; Malau-Aduli *et al.* 2001; Adewumi *et al.* 2006). In previous studies, attention was drawn to the paucity of information on the consumption and

characteristics of sheep milk in Nigeria (Akinsoyinu, 1987, Adewumi *et al.*, 2001; Adewumi, 2007). The West African Dwarf sheep (WAD) described as Fouta Djallon is a small compact, hardy breed (Akinsoyinu, 1987; NAERLS, 1990). The Yankasa is known as "Fulani", a predominant breed in the northern Nigeria. With an estimated population size of 22.1 million (Osinowo, 1992), it has potential for milk production (NAERLS, 1990; FDLPCS, 1991). The Yankasa sheep has been found to have higher milk production than the West African Dwarf (NAERLS, 1990 and Agbede *et al.* 1997). However, the former is not common in the humid zone while

report on the latter as source of milk is scanty.

Measurement of animal body parts, namely; chest girth, loin girth and body weight has been used to determine important functions or parameters such as ejaculate volume and live weight in livestock species (Okon, *et al.*, 1997; Ozoje and Mgbere, 2002; Chineke, *et al.* 2002 and Abdullah *et al.* 2003). There are few reports of body measurements in relation to milk yield. Studies have confirmed that the milk yield of the dairy ewe is associated with udder circumference in cattle and goats (Sing and Dave, 1987; James and Osinowo, 2004), although for non-dairy breeds, there is little evidence available (Haresign, 1983). This experiment is therefore designed to study the effect of genotype and week of lactation on milk yield, udder dimensions and linear body measurement of non-dairy sheep.

Materials and methods

One hundred and ninety two records were taken weekly for twenty four (24) weeks from West African Dwarf (WAD), the Yankasa (YN) and the West African Dwarf X Yankasa crossbred (XB) sheep. The body weight range was 19-22kg and age range between 2-3 years. The study was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure. The animals were fed with concentrate before grazing. Grazing was done between 10.00am and 2.30pm daily. The concentrate contained maize 15%, brewers dry grain 30%, wheat offal 20%, palm kernel cake 34%, salt 0.5% and bone meal 0.5% at 200-500g/head/day. The traits measured were individual milk yield (MK), linear body measurements (LBs) such as height at withers (HT), body length (BL), heart girth (HG), shoulder width (SW), tail length (TL), Neck length (NL),

Neck circumference (NC), Face length (FA), Hind leg length (HL), Foreleg length (FL), Face length (FA), Ear length (EA), Headwidth (HW) and Rump height (RH). Udder dimensions (UD) measured were udder circumference (UC), teat length (TL) and teat circumference (TC) of dams. The UD and LBs were determined in the morning before feeding. The two halves of the udder of each lactating ewes were hand milked early in the morning at 12 hours interval and milk yield was determined using a measuring cylinder once a week for 8 weeks. The lambs were separated between 7 pm and 7 am from ewes which were then milked dry. The weight (WT) was determined using a hanging scale of 0-100kg graduation. The LB's (cm) were measured weekly with the aid of canvas tape. Each animal was gently restrained while taking the measurements. The linear body measurements were defined as follows:

Height at withers: distance between the most cranial palpable spinosus and the ground.

Body length: Distance from the head of the humerii to the distal end of the pubic bone.

Heart girth: Measured as body circumference just behind the foreleg.

Udder circumference: Measured as distance round the widest points of the udder perimeter.

Teat length: Distance between the tip of the teat to the base of the udder

Teat circumference: Distance round the widest points of the teats.

Shoulder width: Measurement taken between the two heads of humerii

Tail length: Measured as distance from distal end of the pubic bone to the tip of the tail.

Neck length: Distance from the head of the humerii to the lateral tuberosities of

the humeri.

Neck circumference: Distance round the mid neck region.

Fore leg length: Distance from the proximal extremity of the olecranon process to the mid lateral point of the coronet.

Hind leg length: Distance from the distal extremity of the olecranon process to the mid lateral point of the coronet.

Face length: Distance from between the horn site to the lower lip.

Ear length: Measured from the base of the ear to the tip.

Rump height: Distance from the highest point of the rump to the ground.

Statistical Analysis

The data generated were analysed by General Linear Model using Statistical Analysis System (SAS, 1995). Significant differences among means were determined using Duncan's multiple range test procedure. Covariate analysis was done to correct differences in initial weight.

The model used was

$$Y_{ijkl} = \sum \sum \sum B_i \sum C_j \sum D_k \sum BC_{ij} \sum bW \sum \sum \sum ijk$$

Where Y_{ijkl} = the traits of interest

(milk yield, udder dimensions and linear body measurements)

$\sum$ = overall mean of all observations

B_i = effect of the i^{th} genotype

(i = West African Dwarf, Yankasa and West African Dwarf x Yankasa)

C_j = effect of j^{th} week of lactation

(j = week 1.....week 8)

bW = body weight used as covariate

BC_{ij} = effect of interaction between i^{th}

genotype and j^{th} week of lactation

$\sum ijk$ = error term associated with each

record of traits, normally, identically and independently distributed with zero mean and variance 1^2e

Results and Discussion

The results of the effects of breed and week of lactation on udder dimensions and linear body measurements are presented in Tables 1-5.

Udder dimension

The results of the analyses on the effects of breed and week of lactation on udder dimensions of West African Dwarf, Yankasa and the crossbred are presented in Table 1. There was a high and significant ($P < 0.05$) effect of breed on TC and UC. Similarly, week of lactation had significant ($P < 0.05$) effect on only MK only. Breed x Week interaction had no significant ($P > 0.05$) on all traits studied. There was no significant difference ($P > 0.05$) in the overall mean weekly milk production in the three genotypes. This is in consonance with the report of Rhind *et al.* (1992) and Al Jassim *et al.* (1999). Comparatively, the MK recorded from the first week till the eight week in this study were lower than those recorded elsewhere (Agbede *et al.* 1997 and Adewumi *et al.* 2006). The mean values of 122.04 ml/day for WAD from the present study was comparable to the corresponding values 121.22ml/day reported in earlier study (Agbede *et al.* 1997) ewes. Also, the mean values of 90.88 ml/day for YN was lower than those reported elsewhere. The WAD was superior in milk production. The WAD genotype produced milk at a relatively low but consistent level throughout the lactation trial. Milk yield was generally low. This could be due to the fact that these animals are of small body size and have not been used for milk production. Peak milk production was obtained at the 3rd and 2nd for WAD and XB respectively and thereafter decreased as lactation advanced ewes. This agrees with the report of Rhind *et al.* (2002)

Table 1: Least square means showing the effects of breed and week of lactation on udder circumference, teat circumference and teat length of West African Dwarf, Yankasa and the crossbred

Week of lactation	West African Dwarf (n=8)				Yankasa (n=8)				Crossbred (n=8)			
	Milk yield and Udder dimensions (cm)				Milk yield and Udder dimensions (cm)				Milk yield and Udder dimensions (cm)			
	MY	UC	TC	TL	MY	UC	TC	TL	MY	UC	TC	TL
1	130.0 ^{abc}	29.1 ^{bc}	3.5	2.5	120.0 ^a	32.6 ^a	6.6 ^a	2.7 ^b	120.3 ^{ab}	31.1 ^a	3.7	3.2
2	139.3 ^{ab}	34.1 ^a	3.2	2.5	117.9 ^a	31.0 ^{ab}	4.3 ^b	2.4 ^b	152.5 ^a	28.7 ^{ab}	3.4	2.6
3	146.1 ^a	29.0 ^{bc}	3.3	2.4	96.5 ^{ab}	26.3 ^c	3.9 ^b	2.7 ^b	126.3 ^{ab}	27.5 ^b	3.6	2.7
4	137.4 ^{ab}	31.0 ^{ab}	3.3	2.3	85.4 ^{ab}	26.8 ^c	3.9 ^b	2.6 ^b	92.4 ^{cd}	27.6 ^b	3.8	2.8
5	123.6 ^{abc}	31.3 ^{ab}	3.4	2.4	79.6 ^b	27.4 ^c	3.7 ^b	2.6 ^b	84.3 ^{cd}	28.6 ^{ab}	3.7	2.7
6	107.9 ^{bc}	29.1 ^{bc}	3.5	2.5	120.2 ^a	27.3 ^c	4.0 ^b	2.5 ^b	118.2 ^{ab}	31.0 ^a	3.6	2.7
7	97.5 ^c	29.5 ^{bc}	3.8	2.5	69.2 ^{bc}	28.7 ^{bc}	3.6 ^b	5.8 ^a	99.8 ^{cd}	28.6 ^{ab}	3.6	2.7
8	96.18 ^c	26.7 ^c	3.7	2.5	38.2 ^c	27.8 ^c	3.5 ^b	2.4 ^b	76.6 ^d	26.6 ^b	3.6	2.7
Mean±	122.3±	30.0±	3.4±	2.4	90.9±	28.5±	4.2±	3.0±	108.8±	28.7±	3.6±	2.7
SE	10.7	1.0	0.3	±	7.7	0.7	0.2	0.3	8.5	0.8	0.2	±
				0.4								0.3

^{abc} Means followed by different superscript(s) within the same column are significantly different (P< 0.05)^{ab} Means followed by different superscripts in different columns across breed are significantly different (P< 0.05)

UC=udder circumference, TC=teat circumference, TL=teat length

who obtained peak milk yield between the 2nd and 3rd week of lactation. However, MK peaked at the 6th week of lactation for YN ewes. This is consistent with the findings of Adewumi *et al.* 2006 and disagrees with the observations of Agbede *et al.* (1997) in WAD and YN ewes, Sakult and Boylan,

1992 in US sheep breeds and Nweje and Manjeli, 1985 in Cameroon Dwarf Blackbelly ewe who obtained their peak milk production at the 4th week of lactation. The observed slight increase in milk production at the 6th week of lactation in YN and XB ewes is difficult to explain.

Table 2: Least square means showing the effects of breed and week of lactation on body length, height at withers and neck length of West African Dwarf, Yankasa and the crossbred

Week of lactation	West African Dwarf (n=8)			Yankasa (n=8)			Crossbred (n=8)		
	Linear Body Measurements (cm)			Linear Body Measurements (cm)			Linear Body Measurements (cm)		
	BL	HT	NL	BL	HT	NL	BL	HT	NL
1	50.4 ^a	60.3	21.0 ^{bc}	56.6 ^{ab}	60.3	23.2 ^{ab}	53.4 ^{ab}	61.8	21.2 ^{ab}
2	49.1 ^a	61.3	23.2 ^{ab}	56.1 ^{ab}	61.3	24.2 ^{ab}	55.5 ^a	60.9	18.7 ^c
3	51.4 ^a	60.0	22.7 ^{abc}	57.7 ^a	60.0	22.9 ^b	55.6 ^a	60.5	18.6 ^c
4	51.0 ^a	60.0	23.4 ^a	54.8 ^{bc}	60.0	24.2 ^{ab}	53.2 ^{ab}	60.4	20.8 ^b
5	50.0 ^a	60.0	23.7 ^a	53.1 ^c	60.0	25.3 ^a	52.3 ^b	61.3	20.8 ^b
6	49.2 ^a	59.1	22.3 ^{abc}	54.6 ^{bc}	59.1	24.1 ^a	53.3 ^{ab}	61.9	21.2 ^{ab}
7	45.7 ^b	59.2	22.0 ^{abc}	54.5 ^{bc}	59.2	24.5 ^{ab}	53.5 ^{ab}	62.2	23.1 ^a
8	49.1 ^a	59.6	20.54 ^c	54.7 ^{abc}	59.6	22.9 ^{ab}	52.8 ^b	60.4	22.7 ^{ab}
Mean±	49.5±	59.9 ±	22.4±	55.2 ±	59.9	23.9 ±	53.7 ±	61.2±	20.9 ±
SE	0.8 ^c	0.8 ^b	0.7 ^b	0.6 ^a	± 0.8 ^a	0.5 ^a	0.6 ^b	0.6 ^b	0.5 ^c

^{abc} Means followed by different superscript(s) within the same column are significantly different (P< 0.05)^{ab} Means followed by different superscripts in different columns across breed are significantly different (P< 0.05)

BL=body length, HT=height at withers NC= neck length

Table 3: Least square means of the effects of breed and week of lactation on neck circumference, heart girth and fore leg length of West African Dwarf, Yankasa and the crossbred

Week of lactation	West African Dwarf (n=8)			Yankasa (n=8)			Crossbred (n=8)		
	Linear Body Measurements (cm)			Linear Body Measurements (cm)			Linear Body Measurements (cm)		
	NC	HG	FL	NC	HG	FL	NC	HG	FL
1	30.4 ^{bc}	70.0 ^{ab}	37.2 ^b	28.5	70.9	45.3 ^{abc}	28.1	64.6 ^{bc}	40.7 ^b
2	31.7 ^{bc}	72.0 ^a	39.8 ^a	28.8	66.1	47.4 ^a	28.1	69.6 ^{ab}	39.8 ^b
3	32.3 ^{ab}	70.1 ^{ab}	36.2 ^b	28.3	69.5	46.0 ^{ab}	28.3	69.7 ^{ab}	39.3 ^b
4	32.1 ^{abc}	70.4 ^{ab}	35.8 ^b	27.4	70.3	45.6 ^{abc}	27.7	69.1 ^{abc}	39.6 ^b
5	32.5 ^{ab}	70.3 ^{ab}	36.1 ^b	26.9	70.8	44.5 ^c	26.6	68.0 ^{abc}	39.5 ^b
6	30.0 ^{bc}	68.1 ^{ab}	35.7 ^b	28.6	68.8	43.2 ^c	26.7	64.1 ^c	43.4 ^a
7	34.5 ^a	65.2 ^{bc}	37.4 ^a	28.8	65.6	43.2 ^{bc}	27.7	71.0 ^a	39.9 ^b
8	29.4 ^c	62.8 ^c	35.6 ^c	27.0	68.6	43.8 ^{bc}	27.7	68.7 ^{abc}	38.8 ^b
Mean±	31.6±	68.6±	36.7±	28.0±	68.8±	44.9±	27.6±	68.1±	40.1±
SE	0.8 ^a	1.6	0.8 ^c	0.6 ^b	1.2	0.6	0.7 ^b	1.3	0.6 ^b

^{abc} Means followed by different superscript(s) within the same column are significantly different ($P < 0.05$)

^{ab} Means followed by different superscripts in different columns across breed are significantly different ($P < 0.05$)

NC=neck circumference, HG=heart girth, FL=fore leg length

Table 4: Least square means of the effects of breed and week of lactation on hind leg length, shoulder width and tail length of West African Dwarf, Yankasa and the crossbred

Week of lactation	West African Dwarf (n=8)			Yankasa (n=8)			Crossbred (n=8)		
	Linear Body Measurements (cm)			Linear Body Measurements (cm)			Linear Body Measurements (cm)		
	HL	SW	TA	HL	SW	TA	HL	SW	TA
1	45.0 ^{ab}	17.9 ^{abc}	27.3 ^a	54.4 ^a	15.0 ^a	41.7 ^a	48.1 ^a	13.9 ^{ab}	30.7 ^a
2	45.4 ^a	18.2 ^{ab}	24.0 ^b	50.6 ^{bcd}	15.8 ^a	39.3 ^b	47.0 ^{ab}	13.5 ^{ab}	29.2 ^a
3	41.7 ^c	16.6 ^{bc}	24.1 ^b	53.0 ^{ab}	14.6 ^{ab}	41.0 ^{ab}	46.6 ^{ab}	14.5 ^{ab}	29.0 ^{ab}
4	43.0 ^{abc}	19.0 ^a	25.7 ^{ab}	52.6 ^{abc}	15.6 ^a	40.1 ^{ab}	46.0 ^{ab}	14.4 ^{ab}	29.4 ^a
5	42.3 ^{bc}	18.6 ^a	26.6 ^a	51.4 ^{abcd}	16.1 ^a	39.9 ^{ab}	45.9 ^{ab}	14.6 ^{ab}	29.8 ^a
6	42.1 ^{bc}	17.3 ^{abc}	23.4 ^b	52.8 ^{abc}	16.3 ^a	40.6 ^{ab}	45.8 ^{ab}	14.7 ^{ab}	30.1 ^a
7	41.9 ^c	16.3 ^c	25.2 ^{ab}	49.9 ^{cd}	15.7 ^a	41.0 ^{ab}	46.5 ^{ab}	14.8 ^a	29.3 ^a
8	42.3 ^{bc}	17.5 ^{abc}	24.3 ^b	49.0 ^d	13.3 ^b	39.8 ^{ab}	44.80 ^b	13.0 ^b	27.1 ^b
Mean±	43.0±	17.7±	25.1±	51.7±	15.3±	40.4	46.3±	14.1±	29.3±
SE	0.9 ^c	0.5 ^a	0.7 ^c	0.7 ^a	0.4 ^b	± 0.5 ^a	0.7 ^b	0.4 ^b	0.5 ^b

^{abc} Means followed by different superscript(s) within the same column are significantly different ($P < 0.05$)

^{ab} Means followed by different superscripts in different columns across breed are significantly different

HL=hind leg length, SW=shoulder width, TA=tail length

Milk yield increased concurrently with increase in UC. The WAD ewes had the highest value of UC and MK. The UC mean values for YN and WAD respectively

were higher than the values (cm) of 18.76, 21.74 and 24.31 obtained by Agbede *et al.* (1997). The TL values (cm) for WAD and XB respectively as observed in this study

were higher than the values of 2.37cm and 2.44cm obtained by Adewumi *et al.* (2006).

Linear body measurements

The results of the analyses on the effects of breed and week of lactation on linear body measurements of West African Dwarf, Yankasa and the crossbred are presented in Tables 2-5. The results of this study revealed that there was a high and significant ($P < 0.05$) effect of breed on BL, HT, NL, NC, HL, SW, TA, RH and TL. Similarly, week of lactation had significant ($P < 0.05$) effect on only HW and FA. Breed effect on UC has been reported by Agbede *et al.* 1997. There was a decrease in all traits studied for all breeds except NL and FA as lactation advanced (Tables 1-5). Though, they were matured animals, growth was observed in the NC and FA (Tables 3 and 5). The overall mean values for all traits in the XB fell between the overall mean values for YN and WAD ewes except NC, HG and HW. The YN ewes were markedly superior

to WD and XB ewes in all body traits except UC, NC and SW.

The highest mean values for BL, HT, FL, HL, HW and UC occurred between the 1st and 3rd week of lactation. Selection for these body traits could contribute to increased milk production in the first three weeks of lactation. The mean value of HT for WAD, YN and XB were 59.95 cm, 68.70 cm and 61.17 cm respectively. Higher figures of HT by Salako and Ngere (2002) and Adewumi *et al.* (2006). The high value of HT and BL in this study implies that YN genotype is taller, longer and bigger in size than the two other genotypes and may be good for mutton. Body withers in animals is more of a function of genetics than of environment. Heart girth (HGT) value were similar to 69.7cm recorded by Afolayan *et al.* (2006) but higher than the values obtained by Adewumi *et al.* (2006) and Taiwo and Odusanya (2001). The mean values for SW were comparable to values of 17.56 and

Table 5: Least square means showing the effects of breed and week of lactation on head width, face length, ear length and rump height of West-African Dwarf, Yankasa and the crossbred

Week of lactation	West African Dwarf (n=8)				Yankasa (n=8)				Crossbred (n=8)			
	Linear Body Measurements (cm)				Linear Body Measurements (cm)				Linear Body Measurements (cm)			
	HW	FA	EL	RH	HW	FA	EL	RH	HW	FA	EL	RH
1	10.0 ^d	20.4 ^c	11.4 ^{abcd}	64.9 ^{abcd}	10.7 ^{bc}	20.6 ^c	12.3	73.1	11.3	21.2	11.1 ^{ab}	66.4 ^{ab}
2	12.1 ^a	19.0 ^d	10.3 ^d	63.8 ^{bcd}	12.0 ^a	22.7 ^{ab}	12.3	73.7	11.4	21.1	10.2 ^{bc}	66.5 ^{ab}
3	10.9 ^{bc}	18.9 ^d	10.4 ^d	62.6 ^d	11.5 ^{ab}	21.9 ^{bc}	12.5	73.3	11.0	20.8	9.9 ^c	66.3 ^{ab}
4	10.3 ^{cd}	21.4 ^{bc}	11.9 ^{abc}	67.3 ^a	11.0 ^{bc}	21.8 ^{bc}	12.5	73.8	10.9	20.7	9.7 ^c	67.3 ^{ab}
5	9.7 ^d	23.0 ^a	12.8 ^a	66.7 ^{ab}	10.7 ^{bc}	22.6 ^{ab}	12.7	75.1	11.0	21.6	10.1 ^{bc}	68.1 ^{ab}
6	11.1 ^b	23.1 ^a	12.1 ^{ab}	65.9 ^{abc}	10.5 ^c	23.4 ^a	12.7	74.0	11.2	21.3	11.0 ^{abc}	69.1 ^a
7	9.9 ^d	22.7 ^{ab}	10.9 ^{cd}	66.1 ^{abc}	10.7 ^{bc}	22.1 ^{abc}	13.3	75.0	11.0	20.8	11.8 ^a	67.4 ^{ab}
8	9.7 ^d	21.3 ^c	11.5 ^{bcd}	62.8 ^{cd}	10.9 ^{bc}	22.2 ^{ab}	13.1	74.7	11.0	20.9	9.9 ^{bc}	65.6 ^b
Mean±	10.5±	21.2±	11.4±	65.0±	11.0±	22.2±	12.7±	74.1±	11.1±	21.0±	10.5±	67.0±
SE	0.3 ^a	0.5	0.4 ^b	1.0 ^c	0.2 ^a	0.3	0.3	0.7 ^a	0.2	0.4	0.3 ^b	0.8 ^b

^{ab} Means followed by different superscript(s) within the same column are significantly different ($P < 0.05$)

^{ab} Means followed by different superscripts in different columns across breed are significantly different ($P < 0.05$)

HW=head width, FA=face length, EA=ear length, RH=rump height

15.08 cm obtained by Salako and Ngere 2002 in YN and WAD respectively. Tail length of YN ewes was higher than 21.79cm and 35.20cm reported by Salako and Ngere (2002) in adult WAD and YN respectively. Tail is longest in YN reaching the hocks than either the WD and XB. The WAD was superior in SW, thereby making the WD broader and blockier in appearance. The XB had the lowest SW. This was in line with the report of Salako and Ngere (2002) on the body dimensions in WAD and YN ewes.

Conclusion

Results obtained from this study indicated that the highest mean values for MK, BL, HT, FL, HL, HW and UC occurred between the 1st and 3rd week of lactation. The WAD ewes were superior in milk production than either the YN or XB while the YN was superior in body traits. Selection for these body traits in WAD ewes could contribute to increased milk production in the first three weeks of lactation.

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