BODY TEMPERATURE AND BLOOD INDICES OF GROWING PIGS FED UNPEELED CASSAVA ROOT MEAL-BASED DIET: FARMERS' PERSPECTIVE

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ABSTRACT

The study investigated the body temperature and blood indices of growing pigs fed a unpeeled cassava root meal-based diet from the farmers' perspective. Eighteen crossbred (Large White x Hampshire) pigs with an average body weight of 20.30±0.30 kg were used for the experiment and arranged in a completely randomised design. Three experimental diets: control – T1 (100% maize-based), 50% and 100% replacement of maize with unpeeled cassava root meal-based diets were formulated and designated as T2 and T3, respectively, and were fed to the animals at 5% of their body weight. The body temperature measurement showed that rectal temperature had a direct relationship with ambient temperature. Dietary treatments had a significant effect ($p<0.05$) on the rectal temperature of growing pigs measured in the morning and evening. Also, dietary treatments influenced the rectal and scrotal temperatures of growing pigs. Pigs fed diet T1 had the highest rectal and scrotal temperatures (38.74°C and 33.80°C), while those fed diet T3 had the lowest values (38.10°C and 29.75°C), respectively. There was a significant increase ($p<0.05$) in the haemoglobin counts of the pigs fed the test diets. The white blood cell counts decreased significantly ($p<0.05$) across treatment groups from pigs fed control diet (T1, 11.20 $x10^9$/L) to those fed unpeeled cassava root meal-based diets (T2, 10.50 $x10^9$/L and T3, 10.09 $x10^9$/L), respectively. Serum parameters (urea N, total protein, and cholesterol) decreased significantly ($p<0.05$) across treatment groups from pigs fed the control to those fed the UCRM diets. The majority (97.7% male and 88.6% female) of the pig farmers identified friends/fellow farmers and family members as the major sources of information on alternative feedstuffs, while interaction with extension agents was poor (11.1% male and 38.0% female) among farmers. It was concluded that sundried unpeeled cassava root meal can be incorporated into the diets of growing pigs without any deleterious effect on the body temperature and blood indices of pigs, but its dissemination to farmers could be hindered considerably if the existing weak research-extension-farmer linkage persists.

Keywords: ***Ambient temperature, Blood parameters, Cassava tuber meal, Growing pigs, Rectal temperature.***

INTRODUCTION

Globally, climate change is responsible for the increase in frequency and intensity of heat waves affecting agriculture, the environment, human and economy (Akatah *et al.,* 2025). With the unprecedented rise in global temperature, livestock species, particularly pigs, are facing devastating impacts, thereby challenging swine nutritionists and farmers to explore potential management options for reducing economic losses. Exposure of pigs to environmental stressors such as high temperature and humidity over a period of time provokes some adaptive behavioural responses such as wallowing in water, seeking shade, and panting to shed the heat load (Vandana and Sejian, 2021). Under prolonged high ambient temperature, the body temperature of pigs rises proportionally, owing to their inability to dissipate body heat via the sweat gland, resulting in heat stress (Scriba and Wechsler, 2021). Heat stress in pigs is triggered by temperatures exceeding the animal's thermo-neutral zone (16 – 25°C). The detrimental effects of heat stress have been reported to encompass various aspects of health, welfare, and production efficiency of pigs (Mayorga *et al.,* 2019). These include a variety of metabolic and immunologic changes leading to reduced feed intake, metabolic and immunologic impairment, disease outbreak, reproductive failure, poor meat quality, decreased weight gain, and increased mortality.

Studies conducted by Govindasamy *et al.* (2022) and Johnson and Stewart (2025) showed that heat stress increased rectal temperature, respiration rate, and plasma cortisol, while it decreased plasma free triiodothyronine and growth hormone. Heat stress had been reported by de Oliveira *et al.* (2023) to cause a 7.3% reduction in voluntary feed intake, while Bunz *et al.* (2019) recorded the largest reduction in farrowing rate on a large farrowing record of Australian piggery monitored between 2012 and 2017 under high environmental temperature that exceeds 29ºC in a 35-day period prior to service. In the United States' swine industry, heat stress is responsible for more than $520 million in losses annually, particularly due to decreased meat production (Liu *et al.,* 2022; U.S. Bureau of Labor Statistics, 2024) and reduced fertility (Liu *et al.,* 2018). In addition, there is also a recent increase in metabolic heat production occasioned by the improvement in genetic selection for large litter size, faster growth and lean carcass traits (Boonkum *et al.,* 2025). These developments have contributed to the need to devise mitigation approaches for combating heat stress in pigs. Studies (Godyń *et al.*, 2020; Wiegert *et al.,* 2022; Johnson and Stewart, 2025) have recommended several options such as the use of evaporative cooling pads, sprinklers and misters, floor cooling, etc., for mitigating heat stress and averting economic losses in pig production. Many of these are not adaptable to small size resource poor farmers who constitute the predominant pig producers in many low-income and emerging countries. A suitable and more affordable option could be achieved through nutritional management.

Nutrition is known to have a significant influence on the environmental physiology of livestock (Choi *et al.,* 2017; Vasco, 2024). The energy density in various feed formulations can be adjusted to lessen the impact of thermal stress occasioned by environmental variables such as ambient temperature and humidity (Lu *et al.,* 2017; Ma *et al.,* 2021). While some feed ingredients such as whole grains, sugar beet pulp, spices, fats and oils, and protein-rich feeds have been reported to have thermogenic properties by subjecting livestock to thermal stress (Slayi and Jaja, 2025), other highly digestible low-energy feedstuffs could generate a lesser impact. High-energy cereal grains generally produce more heat during digestion than highly digestible starches. Likewise, cellulose has a higher heat increment than starch and sugars, whereas fats and oils produce the lowest heat increment. This variation is attributed to greater heat production associated with acetate metabolism compared with propionate metabolism.

In recent times, a global trend in the livestock industry is the inclusion of alternative feedstuffs as a partial or total replacement of the conventional maize, owing to the relatively cheap cost, availability, and lesser competition with human and other industrial uses. In sub-Saharan Africa, particularly Nigeria, cassava and its co-products have gained enormous attention in the diets of livestock, especially poultry and pigs, as a suitable replacement for maize (Adeyemi and Akinfala, 2019). Cassava tuber meal is highly digestible owing to its higher contents of amylopectin than amylose, although it has low crude protein compared to maize. Also, its potential to replace maize in the diets of different classes of pigs has been evaluated (Adeyemi, 2023). Nevertheless, the effects of an unpeeled cassava root meal-based diet on the body temperature of pigs remain poorly documented. Also, few reports exist on pig farmers' views on the impacts of diets on the body temperature of pigs. Meanwhile, pig farmers play a crucial role in shaping perspectives for understanding the critical implications of heat stress on swine production, as well as applying management changes to minimize the impacts on their herds. Therefore, this study was conducted to investigate the effect of unpeeled cassava root meals as a replacement for maize on the body temperature and blood parameters of growing pigs with the aim of providing baseline data for its adoption by local pig farmers.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Swine Unit of Olusegun Agagu University of Science and Technology (OAUSTECH) Farm, Okitipupa, Nigeria. The OAUSTECH farm is situated in the southern senatorial district of Ondo State with geographic coordinates of 6.45358ºN latitude and 4.77279ºE longitude. The experiment took place between May 05 and June 29, 2025. This period marked the beginning of the early rainy season in South West Nigeria.

Preparation of test ingredient and experimental diets

The test ingredient, cassava tuber of Tropical *Manihot* Species (TMS 30572) of about 24 months old, was harvested, the stem was shaken to remove soil from the tuberous roots, and the tuberous roots were prepared following the procedure of Akinfala *et al.* (2019). Depending on the intensity of the sunlight, it took an average of 3 – 5 days to attain a moisture level of 10%. The sundried chopped, unpeeled cassava tuberous roots were milled in a 2 mm sieve using a locally fabricated grinding machine. A basal diet of 18 % crude protein was formulated with 45 % maize. The maize was then replaced with the unpeeled cassava root meal (UCRM) at 50% and 100% in the experimental diets (Table 1). All the diets contained the same amount of other ingredients to match the requirements of growing pigs in the tropics (Aduku, 2012).

Experimental animals, design, and management

A total of eighteen growing crossbred (Hampshire x Large White) pigs of both sexes with an average initial live weight of 20.30±0.30 Kg were used for the experiment. The animals were randomly distributed in a completely randomised design into three dietary groups, namely maize-based (CONTROL – T1), 50% replacement of maize with UCRM (T2), and 100% (total) replacement of maize with UCRM (T3). There were three animals per pen, separated by sex and group-fed on a concrete-floored pen with fixed watering and feeding facilities. Each of the animals served as a replicate. The experimental pigs were fed 5% of their body weight, while water was supplied *ad libitum* throughout the experimental duration. All vaccination and medication schedules were strictly followed, and the experiment lasted for 56 days.

Table 1: Composition of experimental diets

Ingredients (%)	DIETS		
	T1	T2	T3
Maize	45	22.5	-
Unpeeled cassava root meal	-	22.5	45
Soybean meal	8	8	8
Groundnut cake meal	10	10	10
Fish meal	2	2	2
Wheat bran	11	11	11
Palm kernel cake	18	18	18
Bone meal	3.0	3.0	3.0
Oyster shell	2.5	2.5	2.5
Vitamin-mineral premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100.0	100.0	100.0
Calculated Analysis			
Crude protein	17.67	18.25	18.70
Crude fibre	5.44	6.07	6.95
Metabolizable energy (Kcal/Kg)	2834	2769	2720

**Premix (Vit/Min): Vitamin A 10,000,000 IU; Vitamin D 32,000,000 IU; Vitamin E 8,000 IU; Vitamin K 2,000 mg; Vitamin $B_{1\ 2}$,000 mg; Vitamin B_2 5,500 mg; Vitamin B_6 1,200 mg; Vitamin B_{12} 12 mg; Biotin 30 mg; folic acid 600 mg; niacin 10,000 mg; pantothenic acid 7,000 mg; choline chloride 500,000mg; Vitamin C 10,000 mg; Iron 60,000 mg; Mn 80,000 mg; Cu 800 mg; Zn 50,000 mg; Iodine 2,000 mg; Cobalt 450 mg; Selenium 100 mg; Mg 100,000 mg; anti-oxidant 6,000 mg.*

Data collection

Data were taken on ambient, rectal and scrotal temperatures using digital infrared (Model: ANENG TH202) and normal LCD clinical thermometers. The digital infrared thermometer was used to measure the environmental temperature. The normal LCD clinical thermometer was gently inserted into the rectum while the sensor was allowed to touch the scrotal sac of the animals, and temperature readings were recorded. The ambient and rectal temperatures were taken twice daily at 7:00 am and 6:00 pm on three consecutive days weekly, while the scrotal temperature was taken in the last week of the experiment. This was to minimise stress on the animal. Blood samples were taken on a treatment basis via a venepuncture of the jugular vein using a 5ml syringe and needle. Blood samples were collected into EDTA bottles, labelled, and taken to the Laboratory in an ice pack for chemical analysis. Hematological parameters were determined according to the procedures described by Weiss and Wardrop (2010), while serum parameters were obtained by allowing blood samples to clot and centrifuged at 3000 rpm for 10 minutes following the methods described by Kaneko *et al.* (2008).

From the farmers' perspective, information on some farming characteristics of pig farmers was culled from previous studies by Faborode *et al.* (2020) to uncover the information source on feedstuffs, types of feed given to pigs by farmers, and to elucidate the flow of information to pig farmers.

Statistical analysis

Data were subjected to One-way Analysis of Variance procedure using the General Linear Model of SAS 9.2 (2004), while means were separated using the Duncan Multiple Range test at a 95% confidence level.

RESULTS

The results in Table 2 show the weekly average ambient temperature (AAT) and the average rectal temperature (ART) of growing pigs fed cassava tuber meal-based diets. The values obtained for the AAT ranged between 25.92 °C and 27.58 °C, with the minimum and maximum values recorded in weeks 6 and 3, respectively. The difference between the maximum and minimum AAT during the experimental duration was 1.60 °C. The ART ranged between 38.25 °C in week 5 and 39.32 in week 4, with a difference of 1.07 °C. This may imply that, given an ambient temperature, the rectal temperature can be estimated.

Table 2: Weekly average Ambient temperature vs average rectal temperature of growing pigs fed experimental diets

Weeks	Average ambient temperature (°C)	Average rectal temperature (°C)
1	27.20 ± 0.02^a	38.40 ± 0.06^a
2	26.85 ± 0.05^a	38.60 ± 0.05^a
3	27.58 ± 0.05^a	38.88 ± 0.03^a
4	26.15 ± 0.03^a	39.32 ± 0.03^a
5	27.00 ± 0.06^a	38.25 ± 0.06^a
6	25.92 ± 0.03^a	38.60 ± 0.04^a
7	27.40 ± 0.04^a	39.10 ± 0.05^a
8	26.78 ± 0.05^a	39.28 ± 0.03^a
Mean	26.86 ± 0.04^a	38.80 ± 0.09^a

Values having the same superscript do not differ significantly (p<0.05)
Means± standard error of the mean

Table 3 shows weekly records of average ambient and rectal temperatures of growing pigs taken in the morning and evening. The lowest and highest morning AATs were recorded in weeks 1 and 4, respectively, while for the evening records, the minimum and maximum AATs were found in weeks 6 and 1, respectively. The records show a difference of 2.30 °C for the morning AATs, while for the evening temperature readings, the difference was 3.62 °C. For the average rectal temperatures taken in the morning, the lowest was 38.20 °C and recorded in the 7th week of the trial, while the highest was 39.32 °C, recorded in week 6. The average rectal temperatures for the evening measurements ranged between 38.83 °C and 39.53 °C. The lowest and highest temperature values were recorded in weeks 4 and 1, respectively. The average morning ambient temperature for the entire experimental duration was 25.23 °C, while the average rectal temperature taken at the same time was 38.80 °C. The difference between the two averages was computed (38.80 °C – 25.23 °C) as 13.57 °C. Therefore, the morning rectal temperature could be estimated from the morning ambient temperature as 13.57 °C + morning ambient temperature + the error due to variations. The highest evening ambient temperature of 29.80 °C was recorded in week one, while the lowest temperature (26.18 °C) was found in week six. The evening rectal temperature was highest (39.53 °C) in week one and lowest in week four of the experiment. The mean evening AAT for the experimental duration was 27.40 °C, while the mean evening RT was 39.35 °C. The difference between the two temperatures was 11.95 °C. The evening RT could also be estimated from evening AT by adding the difference (11.95 °C) to the value obtained for evening AT.

Table 3: Weekly records of ambient and rectal temperatures of growing pigs at different times of the day

	Morning temperature (°C)		Evening temperature (°C)	
Weeks	**Ambient**	**Rectal**	**Ambient**	**Rectal**
1	24.00±0.03[a]	38.95±0.07[a]	29.80±0.06[a]	39.53±0.05[a]
2	26.20±0.03[a]	39.05±0.06[a]	26.50±0.04[a]	39.20±0.09[a]
3	25.42±0.05[a]	38.30±0.06[a]	27.00±0.03[a]	39.10±0.06[a]
4	26.30±0.03[a]	38.80±0.10[a]	26.20±0.05[a]	38.83±0.03[a]
5	25.75±0.04[a]	39.03±0.08[a]	27.10±0.03[a]	39.18±0.05[a]
6	24.10±0.05[a]	39.32±0.06[a]	26.18±0.06[a]	39.40±0.04[a]
7	25.60±0.03[a]	38.20±0.07[a]	27.50±0.05[a]	39.18±0.03[a]
8	24.50±0.05[a]	38.50±0.10[a]	28.65±0.03[a]	39.35±0.05[a]
Mean	25.23±0.04[a]	38.80±0.08[a]	27.40±0.04[a]	39.35±0.05[a]

Values having the same superscript do not differ significantly ($p<0.05$)
Means ± standard error of the mean

The results in Table 4 show the fluctuations in ambient temperature with rectal temperature across the three dietary groups taken in the morning and evening. With a morning ambient temperature of 25.50°C, the morning rectal temperature varied between 37.21°C in experimental pigs fed diet T3 and 37.58°C in those fed diet T1. For the evening ambient temperature, the values were comparable across treatment groups ($p>0.05$), but the experimental pigs fed diet T1 produced the most thermogenic effect on the rectal temperature of experimental pigs, while those fed diet T3 had the significantly lowest rectal temperature value.

Table 4: Impact of dietary treatments on ambient and rectal temperatures of growing pigs taken at different times of the day

	Morning temperature (°C)		Evening temperature (°C)	
Diets	**Ambient**	**Rectal**	**Ambient**	**Rectal**
T1	25.50±0.32[a]	37.58±0.14[a]	29.15±0.06[a]	39.74±0.10[a]
T2	25.50±0.32[a]	37.42±0.11[a]	29.15±0.06[a]	39.51±0.09[a]
T3	25.51±0.31[a]	37.21±0.10[b]	29.13±0.04[a]	39.36±0.11[b]
Mean	25.50±0.32[a]	37.40±0.12[a]	29.14±0.05[a]	39.54±0.10[a]

T1: Control/ Maize based diet; T2: 50% unpeeled cassava root meal-based diet; T3: 100% unpeeled cassava root meal-based diet
Values having the same superscript do not differ significantly ($p<0.05$); Means± standard error of the mean

The ambient, rectal, and scrotal temperature of growing pigs fed experimental diets is shown in Table 5. The average ambient temperature across the treatment groups did not vary significantly ($p>0.05$). However, the average rectal temperature of growing pigs fed experimental diets varied across treatment groups; pigs on the control diet had a higher value (38.74°C) compared to those fed graded levels of unpeeled cassava root meal-based diets. Pigs fed a 100% replacement of maize with unpeeled cassava root meal had the lowest (38.10°C) ART. There was a significant influence of dietary treatments on the average scrotal temperature of growing pigs fed experimental diets. Again, the average scrotal temperature reduced in pigs fed partial and total replacement of maize with unpeeled cassava root meal; pigs fed the control diet had the highest value (33.80°C) compared to those fed 50% unpeeled cassava root meal (31.00°C), while those fed total replacement of unpeeled cassava root meal had the least (29.75°C) average scrotal temperature.

Table 5: Ambient, rectal, and scrotal temperatures of growing pigs across treatment groups

Diets	Average ambient temperature (°C)	Average rectal temperature (°C)	Average scrotal temperature (°C)
T1	24.90±0.10[a]	38.74±0.08[a]	33.80±0.24[a]
T2	24.90±0.10[a]	38.36±0.06[b]	31.00±0.00[b]
T3	24.90±0.10[a]	38.10±0.07[c]	29.75±0.05[c]
Mean	24.90±0.10	38.40±0.07	31.52±0.10

T1: Control/ Maize based diet; T2: 50% unpeeled cassava root meal-based diet; T3: 100% unpeeled cassava root meal-based diet
Values having the same superscript do not differ significantly (p<0.05)
Means± standard error of the mean

The haematological parameters of growing pigs fed experimental diets are shown in Table 6. The White Blood Cells (WBC) counts were highest (p<0.05) in the pigs fed the control diet. Pigs fed 50% and 100% unpeeled cassava root meal-based (UCRM) diets in replacement of maize had significantly lower (6.25% and 9.91%) WBC counts compared to those fed the control diet. However, pigs fed 50% and 100% UCRM diets had significantly higher (1.32% and 2.20%) Hb counts than those fed the control diet. Also, the Red Blood Cell (RBC) counts of pigs fed 50% and 100% UCRM diets had higher (3.63% and 5.96%) counts than those fed the control diet. The fewer counts observed in pigs fed the control diet could suggest dehydration of the pigs due to heat stress. The serum concentration of glucose decreased significantly (p<0.05) from pigs fed the control to those fed the 50% UCRM-based diet; it was least in pigs fed total replacement of maize with UCRM-based diet. Though cassava contained highly digestible starch, the efficiency of energy utilisation of UCRM may be lower compared to maize. The blood urea nitrogen was higher in pigs fed the control diet than in those fed a 50% UCRM-based diet, while pigs fed the total (100%) replacement of maize with UCRM had the lowest value. Total protein and albumin in the serum were higher in pigs fed the control than in those fed the UCRM-based diets, while the globulin contents increased non-significantly from the pigs fed the control diet through those fed the UCRM-based diets. Also, the cholesterol concentration decreased significantly (p<0.05) across treatment groups from pigs fed the control to those on a 50% UCRM-based diet, while pigs fed with 100% UCRM-based diet had the least value.

Table 6: Haematology and serum indices of growing pigs fed experimental diets

Parameters	DIETS T1	T2	T3	p-level	±SEM
White blood cells, x10^9/L	11.20^a	10.50^b	10.09^c	0.004	0.21
Red blood cells, x10^{12}/L	6.80	6.89	6.95	0.47	0.04
Haemoglobin (Hb), g/L	115.8^b	120.0^a	122.7^a	0.03	1.60
Glucose, mg/dL	125.0^a	115.70^b	107.50^c	0.001	3.75
Urea nitrogen, mg/dL	30.43	27.83	24.40	0.49	1.80
Total protein, g/dL	7.05	6.54	6.32	0.32	0.19
Albumin, g/dL	3.85	3.72	3.64	0.91	0.16
Globulin, g/dL	3.40	3.79	4.00	0.48	0.19
Cholesterol, mg/dL	106.25^a	90.36^b	79.00^c	0.03	5.40

T1: Control/ Maize based diet; T2: 50% unpeeled cassava root meal-based diet; T3: 100% unpeeled cassava root meal-based diet
Values having the same superscript do not differ significantly (p<0.05)
Means± standard error of the mean

The analysis of the characteristics of pig farmers in Table 7 revealed an average age of 33.6±7.15 years. Notably, the purpose of pig farming has transitioned from domestic to commercial, as revealed by the majority (90.1% and 88.6%, respectively) of males and females engaging in pig farming. Also, the average herd size (9.8±2.45 pigs) revealed that most of the farmers were still engaged in backyard pig farming. Importantly too, the main source of information on alternative feedstuffs was friend/fellow farmers and family members (97.7% and 88.6% for male and female respondents, respectively), while extension service providers provided information for very few (11.1% and 38.0% for male and female) farmers. The implication of this result is that pig farmers may not be aware of much beneficial information due to the weak linkage between the farmers and the extension agents.

Table 7: Farming characteristics of pig farmers

Variables	Male Frequency	Male Percentage	Female Frequency	Female Percentage	Mean±SD
Age (Years)					
≤ 35	115	56.1	24	25.3	
36 – 45	55	26.9	39	40.5	
46 – 55	13	6.4	14	15.2	
55 – 65	18	8.8	18	19.0	
≥ 65	4	1.8	-	-	33.6±7.15
Reason for raising pig					
Consumption	12	5.8	4	3.8	
Sales	185	90.1	84	88.6	
Gift	8	4.1	7	7.6	
Herd size					

Variables	Male Frequency	Male Percentage	Female Frequency	Female Percentage	Mean±SD
≤ 10	108	52.6	53	55.7	
11 – 20	69	33.9	35	36.7	
>20	26	13.5	7	7.6	9.8±2.45
Types of feed fed to pigs					
Conventional	34	16.4	6	6.3	
Alternative	174	84.8	72	75.9	
Alternative and conventional	56	28.1	30	31.7	
***Sources of information on alternative feedstuffs**					
Family members	95	46.8	84	88.6	
Friends/fellow farmers	200	97.7	54	57.0	
Extension agents	23	11.1	36	38.0	
Religious groups	88	42.7	67	70.9	
Radio	126	61.4	38	40.5	
Market places	18	8.8	84	88.6	

**Multiple responses*
Source: Faborode et al. (2020)

DISCUSSION

Rectal temperature of pigs is a commonly used indicator for assessing heat loads. The direct variations observed between the ambient and rectal temperatures of growing pigs fed the experimental diets can be attributed to the low capacity for sweating observed in pigs. The non-significant fluctuations in ambient temperature throughout the experimental duration are in tandem with the records obtained for the rectal temperature. This implies that the environmental condition was uniformly stable over time, so that it could not generate enough variation to sufficiently influence rectal temperature. Similar findings were reported by Aro and Ajiboye (2016), who evaluated the effects of composite leaf meal diets on the body temperature of growing pigs. This result agrees with the range of body temperature (26.0°C – 38.0°C) reported by Johnson and Stewart (2025) for different categories of pigs.

All the average ambient and rectal temperatures of growing pigs taken in the morning and evening periods were within the range of the thermo-neutral zone for efficient performance and productivity. Also, the observed significant decrease in scrotal and rectal temperatures of pigs fed the experimental diets under the same ambient temperature could be due to the decrease in thermogenesis arising from the energy density and carbohydrate composition of the test diets. Since the performance of pigs is influenced by environmental factors such as ambient temperature, humidity and nutrition, any significant variations in ambient temperature and photoperiod can compromise reproductive efficiency, particularly contributing to seasonal fertility in pigs (Flowers, 2022). Also, high ambient temperature above the thermo-neutral zone has been found to adversely affect the metabolic and physical activities of pigs by reducing voluntary feed intake, meal frequency, and reproductive performance of pigs (Oliveira *et al.,* 2018; Mun *et al.,* 2022).

Blood traits reflect the health, nutrient, and immune status of animals. Since heat stress substantially affects the blood biochemical profile, it is a commonly used indicator. The observed significant decrease ($p < 0.05$) in the WBC counts obtained in pigs fed the UCRM-based diets may be a reflection of residual cyanogenic glycosides, though tolerable, that are present in the cassava diets, which may have contributed to reduced production of leukocytes. Also, the increment in red blood cell and haemoglobin counts of pigs fed UCRM-based diets may suggest a destruction of erythrocytes occasioned by heat stress in pigs. A similar trend had been reported by Rudolph *et al.* (2024). High environmental temperature contributes to heat stress and alters blood circulation, oxygen transport, and erythrocyte physiology, which may contribute to changes in RBC and Hb values (Omotosho *et al.,* 2024). When animals are exposed to heat stress, glucocorticoids are released into the body, causing the breakdown of lymphocytes involved in the production of antibodies. Therefore, heat stress affects specific immune systems and reduces the number and activity of leukocytes (Khan *et al.,* 2021).

For the serum indices, the lower blood glucose observed in pigs fed UCRM-based diets could be attributed to the rapidly digestible and absorbable carbohydrate present in cassava (amylopectin), which could spontaneously increase blood glucose after feeding and be rapidly followed by a fast glucose clearance. Also, the timing between fasting and post-feeding may have contributed to the observed variations in blood glucose values. This result is consistent with the reports of the studies conducted by Vasquez *et al.* (2022) on the effect of different exposure periods on performance and blood parameters of growing pigs. Pigs respond to the rise in body temperature by increasing muscle activity and energy expenditure (Fausnacht *et al.,* 2021). As a result of these physiological adaptive responses, the pigs could exhibit a decrease in fat mobilization, suppressed protein deposition and increased protein utilization to synthesize glucose as an energy source for maintenance. These findings are in agreement with those of Gonzalez-Rivas *et al.* (2020) and Prates (2025). Studies by Ma *et al.* (2021) and Lu *et al.* (2017) reported that heat stress induces fat synthesis and deposition, which worsens the energy expenditure. The reduction in energy uptake and the increase in energy consumption cause a deficit in the energy supply, resulting in the breakdown of glycogen in the body (glycogenolysis) to meet the energy expenditure response to heat stress (Ma *et al.,* 2021).

The reduction in serum cholesterol contents of growing pigs fed UCRM-based diet could be due to some characteristics of cassava fibre to physically sequester bile acids in the gut and reduce the reabsorption potential, thereby forcing the liver to convert more cholesterol into new bile acids. This results in decreased lipid and cholesterol absorption, higher bile acid adsorption, retarded cholesterol biosynthesis and increased cholesterol catabolism to produce bile acid. This had been similarly reported by Akinola *et al.* (2024), who evaluated the performance and serum metabolites of growing pigs fed a microbial-degraded cassava peel-leaf meal diet and recorded a decline in serum cholesterol in pigs fed the treated diet.

From the farmers' perspective, it was evident that the majority of the farmers were young, full of zeal, physical strength, and very vast in technology usage; however, their major sources of information on alternative feedstuffs were friends/ fellow farmers and family members. This scenario points to a major disconnect between researcher-extension-farmer linkage earlier reported by Faborode and Ajayi (2015). Recent studies

(Shang *et al.,* 2023; de Oliveira *et al.,* 2024; Johnson and Stewart, 2025), however, revealed that researchers and farmers are becoming more aware of the relationship between dietary composition, feeding practices and thermal stress management, especially in growing pigs. This information may not be generally true among local farmers who have limited access to research outcomes via weak extension linkage. Thus, it is of utmost importance to provide suggestions for creating awareness and promoting utilisation of available better feedstuffs to enhance pig farmers' production and economy.

CONCLUSION

Based on the findings of the study, it was concluded that sundried unpeeled cassava root meal can be incorporated in the diets of growing pigs without any deleterious effect on the body temperature and blood indices of growing pigs, but its dissemination to farmers could be hindered considerably if the existing weak research-extension-farmer linkage persists.

RECOMMENDATIONS

1. It is more expedient than ever before to scale up the proven UCRM research outcomes to the pig farmers
2. There is a need for the government to invest considerably in strengthening the existing weak linkage between the farmers and the public extension service to bridge the knowledge gap
3. Sensitisation on the UCRM campaign should be embarked upon using an individual farm visit approach, mass and social media, religious organisations, and markets to create awareness

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