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Research Article

Performance of Boran and Two Strains of Tanzania Short Horn Zebu Cattle Fed on Three Different Diets

Khatibu Abdallah Salum[1, *], **Germana Henry Laswai**[1], **Daniel Elia Mushi**[1, 2]

[1]Department of Animal, Aquaculture and Range Sciences, Collage of Agriculture, Sokoine University of Agriculture, Morogoro, Tanzania

[2]Ministry of Livestock and Fisheries, Livestock Sector, Dodoma, Tanzania

Abstract

A 3x3 factorial experiment was carried out to assess the performance of Boran breed (BRN), Iringa Red (IRR) and Singida White (SWT) strains of cattle fed on three different diets (D1, D2, and D3) under a feedlot condition. The diets contained hominy feed plus molasses (D1 or control), molasses and cassava meal (D2) and rice polishing (D3) as main energy sources. In addition, they contained sunflower seed cake as protein source, minerals and vitamins premix. Fifty-four (54) bulls of equal numbers of each strain, aged between 2 and 2.5 years and average initial weight of 194 ± 12.6 kg were randomly allocated in the three diets and housed in a feedlot structure. They were fed individually with their respective dietary treatments for 80 days, during which data on feed intake and growth performance were recorded. Thereafter 45 bulls with equal number of strains were slaughtered, and carcass characteristics were assessed and gross margins computed. The CP contents (g/kg) in the diets were highest in D2 (155), followed by D1 (141.7) and lowest (130) in D3. There were no significant ($P>0.05$) interaction effect of diet and breed/strain in all the parameters assessed on performance. Bulls fed on D2 grew faster (0.99 kg/d) and attained greater final weight (269.9 kg) and heavier carcasses (140.8 kg) followed by those fed on D1 with mean values of (0.92 kg/d), (258.1 kg) and (131.5 kg), respectively. The average dressing percentage followed a similar trend, being higher ($P<0.05$) in bulls fed on D2 (52.4) compared to those on D1 (51.7) and D3 (51.1). The BRN bulls had faster growth rates (1.04 kg/d) followed by the IRR (0.83 g/d), which had similar ($P>0.05$) average daily gain to that of SWT (0.83 g/d). The final weight of BRN bulls (267.4 kg) was not different ($P>0.05$) from that of IRR (257.5 kg), which was also found to be similar ($P>0.05$) to that of SWT (251.2 kg). The hot carcass weights followed similar trend, BRN having carcass weight (138.2 kg) similar ($P>0.05$) to IRR (130.4 kg), which happened to be not different ($P>0.05$) from that of SWT (129.3 kg). The mean dressing percentage was higher ($P<0.05$) for BRN (52.2) than other strains. It is concluded that value of weight gains and slaughter characteristics of Iringa red are comparable to those of Boran, thus for feedlot finishing farmers should be advised to select and use Iringa red bulls to obtain high carcass and large profit.

Keywords

Boran, Iringa Red, Singida White, Feedlot, Weight Gain

[*]Corresponding author: khatib75@yahoo.com (Khatibu Abdallah Salum)

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1. Introduction

Tanzania has a large number of livestock, which supply red meat as a source of protein and support the livelihoods of many rural and urban dwellers. It ranks second in Africa after Ethiopia in terms of cattle population, with about 36.6 million cattle, 26.6 million goats, and 9.1 million sheep [1]. In spite of the large number of livestock, the contribution to GDP is low, at 7%, and average per capital meat consumption is 12 kg, which is below the 50 kg recommended by FAO [2]. It is estimated that 90 to 98% of cattle in Tanzania are Tanzania Short Horn Zebu (TSHZ), with their 12 strains, including Iringa Red, and Singida White [3]. These strains differ from one another in features such as coat color, body size, morphology, and adaptability to the environment; they can survive in harsh environments such as feed and water shortages [4]. Their poor performance traits, such as low carcass weight, tough meat, and a low level of marbling, are attributed to finishing on poor quality pasture and insufficient water leading to a slow growth rate making the animals take a long time to attain slaughter weight [5]. These limitations could be solved through feedlot finishing of these animals before slaughter. Previous studies in Tanzania showed the performance in the range of 618 -1280 g of average daily gain in TSHZ finished on feedlot [6, 7]. The variation in average daily gain was associated with the difference in cattle strain, feed intake and quality of formulated diet. The diets with highest values of energy and protein contents produce the highest performance in meat production [8]. Due to rising price of ingredients for concentrate feeds such as grains use of concentrates feeds for fattening process is becoming expensive. There is thus a need to look for alternative cheap ingredients for compounding concentrate diets for feedlot finishing cattle [9]. Luckily Tanzania has abundant of feed resources suitable for fattening beef cattle in feedlot including agriculture wastes and industrial by products, which in the past few years they were considered environmental pollutants, but now days these resources are used as cheapest source of feeds for livestock which can be formulated and used in beef fattening industries and other livestock feeds [10]. By targeting the specific strains among Tanzanian Short Horn Zebu cattle and finishing them in feedlots could lead to a specific package of diet and strains that can perform well when finished in feedlots. Since some strains, such as the Iringa Red, have a large body frame size, hind leg length compared with other strains of TSHZ therefore finishing them under feedlots may produce large carcasses with T-bone steak of 250g required by the niche market [11]. Other researchers show some strains of Tanzania Short Horn Zebu cattle such as Iringa red strains have good body conformation, which makes them suitable for meat production [12]. This present study was carried out to investigate growth performance, slaughter and carcass characteristics of two Tanzania Short Horn Zebu cattle strains that are Iringa red and Singida White, when fed on different diets formulated from locally available feed stuffs.

2. Materials and Methods

2.1. Description of the Study Area

The study was carried out at Kongwa Ranch, which is one of the National Ranches in Tanzania. It is located at Kongwa District, lies between latitudes 6 °12'0" South and longitudes 36 °25'0" East. The climate of the area is semi-arid, with annual rainfall ranges from 500 to 800 mm and temperature varies from 20 ℃ to 33 ℃.

2.2. Experimental Design and Treatments

Fifty-four (54) bulls of equal numbers of Boran breed, Iringa red and Singida White strains were allocated randomly in three dietary treatments, D1, D2 and D3 in a 3 x 3 factorial arrangement. The diets contained hominy feed and various levels of molasses (D1), cassava meal (D2) and rice polishing (D3) as main energy sources and sunflower seed cake (SSC) as a major protein source. Diet D1 was a positive control diet, which produced best performance in the previous study [13] on finishing TSHZ bulls under feedlot conditions.

2.3. Sources of Feeds and Feeding

The three dietary treatments were formulated using the locally available feed resources applying the computer Microsoft Excel add-in program SOLVER [14] to contain 11 MJME and 140 g CP per kg DM (Table 1). These specifications were adequate to meet the energy and protein requirements for fattening beef cattle in accordance to NRC [15].

Table 1. *Physical composition (g/kg as fed) of the experimental diets.*

Ingredients	Dietary treatment[1]		
	D1	D2	D3
Hominy meal	580	580	510
Rice polish	0	0	330
Cassava meal	0	150	0
Molasses	180	30	0
Sunflower seed cake	220	220	140
Minerals	15	15	15
Salt	5	5	5
Total	1000	1000	1000
Calculated composition			
CP (% DM)	11.12	11.27	11.03

Ingredients	Dietary treatment[1]		
	D1	D2	D3
ME (MJ/kg DM)	14	14	14
Estimated cost (Tshs)[2]	500	500	450

[2]Tshs: -Tanzanian shillings equivalent to $4 x 10^{-4}

The hominy meal and sunflower seed cake (SSC) were sourced from the maize milling and oil extraction plants, respectively found in Kibaigwa town in Kongwa district, while molasses was procured from Mtibwa Sugar Industry in Morogoro, where it was packed in drums of 20 litters and transported to Kongwa ranch. The cassava roots were obtained from the cassava farmers in Tanga region and processed following procedures for inactivating the cyanide that were washing, slicing with its peels, drying under the sun and course ground. Samples of the feed ingredients and formulated diets were collected and chemically analysed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), ash and nitrogen free extractives (NFE) according to the procedures of AOAC [16]. The metabolizable energy (ME) contents of the diets were predicted using the formula by MAFF [17];

$$ME\ (MJ/kg\ DM) = 0.012\ CP + 0.031\ EE + 0.005\ CF + 0.014\ NFE \quad (1)$$

2.4. Source of the Experimental Animals and Their Management

The 54 experimental bulls, aged between 24–30 months, with an average initial weight of 194 ± 12.6 kg were obtained from Kongwa Ranch. Prior the initiation of the experiment, the bulls were backgrounded for 14 days, during which they were all grazed in one paddock to attain similar body condition. The bulls were ear tagged with plastic ear tags for easy management and recording. They were then weighed for three consecutive days, whereby the average of the three weights was taken as their initial body weight. The bulls were then grouped into their specific breed/strains that are Boran (BRN), Iringa Red (IRR) and Singida White (SWT), each group having 18 bulls. Within the groups, they were randomly allocated into the three experimental diets (D1, D2 and D3). The bulls were housed into a timber-constructed structure consisted of 54 separate pens for individual animal, each with dimensions of 4 x 5 m. In each pen, there were three separate troughs for concentrate, hay and drinker. Before starting of the feeding experiment, all the bulls were dewormed using Albendazole suspension solution (10% W/V) to control endoparasites. In addition, they were vaccinated against Foot and Mouth and Contagious Bovine Pleural Pneumonia diseases. For controlling ticks, the animals were sprayed weekly with acaricide Paranex 300 EC using a knapsack sprayer.

A ten (10) day period was allowed for adapting the experimental animals to the dietary treatments. Feeding was individually, whereby each bull was supplied with the respective dietary treatment ad libitum. A weighed amount of feed was apportioned into two and fed in the morning at 08:00 h and evening at 16:00 h. The amount of feed refused was collected and weighed in the morning before the next offer to determine the feed intake by taking the amount of the feed offered minus the feed refused in kilograms. In addition, all experimental animals had free access to hay and clean drinking water. They were weighed fortnightly and their weight changes were used to estimate the amount of feed required. The feeding experiment lasted for 80 days, during which the final weight was estimated by taking the average of three body weight of the animals in three consecutive days. Weight gain in kilogram was derived by taking the final weight minus the initial weight. The average daily gain in grams was estimated as the weight gain divided by the number of days in the feedlot. The feed conversion ratio in kilograms per unit gain was determined by taking the average daily gain divided by feed intake.

2.5. Slaughter Procedure and Determination of Slaughter Characteristics

At the end of the 80 days of feeding period, forty-five (45) bulls, fifteen (15) from each breed/strain and diet were randomly selected for slaughtered. The selected bulls were taken to the slaughterhouse at Kongwa, where they were fasted for 12 hours in the lairage with access to drinking water. In the following morning the bulls were weighed to obtain slaughter weight and taken to abattoir where they were stunned and slaughtered, Stunning was done by knocking on the upper part of the head between horns using hammer to unconscious. They were then slaughtered by cutting the head between the occipital and atlas bone according to Hallal rituals.

Dressing procedures such as skinning and evisceration, where the gastro-intestinal tract (GIT) was removed were done immediately after the animals have been slaughtered. The weight of full GIT (FGIT) in kilogram was recorded. The weight of empty GIT (EGIT) was obtained by removal of gut content. The difference between the weights of FGIT and EGIT gave the weight of the gut content (GC). The empty body weight (EBW) was determined by taking the slaughter weight minus the GC. The internal fat (INF) was determined by weighing the mesenteric fat, kidney fat and the abdominal fat, while the weights of liver, kidneys, heart and spleen represented the internal organs (INO). The fore and hind feet were removed by cutting the carpal-metacarpal joint and tarsal-metatarsal joint, respectively and weighed. The carcass was separated into two halves by cutting along the midline of the vertebral column. The hot carcass weight (HCW) in kilogram was determined by weighing the two halves of the carcass from each bull using a hanged weighing scale. The dressing percentage (DP) was calculated by expressing the hot carcass weight as percent of the slaughter weight.

2.6. Economic Analysis

The economic analysis of the finishing bulls in the feedlot was performed by computing the gross margins, These were obtained by computing the total revenue earned from all income sources subtracting the total variable costs incurred. The total revenue was obtained from the sales of the hot carcasses by the market price of Tsh. 9,000.00 per kg. Other animal parts, such as liver was sold at Tsh. 12,000.00 per kilogram, whereas offal and feet at Tsh. 2,000.00 per kg. The total variable costs included purchasing of bulls at Tsh. 3,500.00 per kilogram of live weight of a bull. The average cost of the concentrates feeds and hay used for each treatment was estimated by the average concentrate consumed by the specific bulls multiplied by the respective cost (Table 1) of the dietary treatment. The cost of hay was Tsh 3,000.00 per bale, where 8 bales were used per day for all treatments. The cost of water was assumed the same for all bulls, thus calculated as requirement of 50 liters per bull per day multiplied by the unit price of water.

The effects of the dietary treatments and breed/strains on the parameters assessed were analyzed according to the 3 x 3 factorial model. The differences between breed/strains, diets and the interaction effects of diets and breed/strains were considered significant at $P \leq 0.05$.

3. Results

3.1. Nutritional Values of the Feedstuffs

Table 2 presents the results of the chemical composition of feedstuffs and formulated diets used in the study. Among the ingredients used in formulating diets, the highest value of crude protein (CP) content was found in sunflower seed cake, while the lowest value was obtained in cassava meal. The highest value of ME content was in cassava meal, while the lowest value observed in molasses. Among the formulated diets, D2 contained the highest, while D3 had the lowest values of both CP and ME contents.

Table 2. *Chemical composition (g/kg DM) of the feedstuffs and formulated diets used in the study.*

Feedstuffs[1]	DM[2]	ASH	CP	EE	CF	NFE	ME[3] (MJ/kg DM)
MB	900	48.7	146.2	15.5	62.8	626.95	11.32
SSC	935	108.3	242.6	20.0	232.6	331.1	9.33
CSM	875	38.9	15.7	4.4	32.7	783.3	11.45
RP	873	99.2	125.7	19.9	90.6	537.62	10.1
Molasses	789	149.6	43.2	11.0	0.0	595.1	8.88
Hay	859	96.9	62.0	18.6	307.4	373.6	8.09
Formulated diets							
D1	915	173.0	141.7	124.3	115.4	361.0	11.18
D2	903	112.5	155.0	107.1	118.5	410.0	11.51
D3	919	182.7	130.2	73.5	126.2	406.0	10.16

[1]MB = Maize bran, SSC = Sunflower seed cake, CSM = Cassava meal, RP = Rice polishing; [2]DM=dry matter; EE = ether extract; CP = crude protein; CF=crude fibre, NFE=nitrogen free extract; [3]ME = metabolizable energy.

3.2. Effects of Diets and Strains on Feed Intake and Growth Performance of the Bulls

The effects of diets and breed/strains on feed intake and growth performance of the bulls during the experiment are presented in Table 3. Mean feed intake (FI) was higher ($P<0.05$) for bulls fed on Diet D3, although the mean value was not different ($P>0.05$) from those fed on D2. The differences in the mean initial body weight of the bulls were neither significant ($P>0.05$) between strains nor dietary treatments. Bulls fed on D2 grew faster ($P<0.05$) and attained greater final weight (FW) and total weight gain (WG) than their counterparts. The least WG was obtained with the bulls fed on D3, which also had higher ($P<0.05$) mean value of feed conversion ratio (FCR). The Boran (BRN) bulls showed the highest ($P<0.05$) average FI, WG and average daily weight gain (ADG) compared to their counterparts. The mean differences in the FW and ADG between BRN and Iringa Red (IRR) were, however not significant ($P>0.05$). Furthermore, BRN bulls had lowest ($P<0.05$) value of FCR while Singida White (SWT) showed the highest value. The interaction effects between diets and strains were not significantly different ($P>0.05$) for all the parameters measured on the feed intake and growth

performance of the bulls.

Table 3. The Ls means of the effects of diets and strains on the growth performance of the bulls.

[1]Parameter	[2]Diet			[3]Strain			[4]SEM	[5]P values		
	D1	D2	D3	BRN	IRR	SWT		Diets	Strains	[6]Diets x Strains
FI	6.77^{b}	6.82^{ab}	6.84^{a}	7.00^{a}	6.78^{b}	6.65^{b}	0.020	0.0443	0.0001	0.1027
INW	193.7	199.5	192.5	194.6	198.9	192.2	3.16	0.2554	0.3377	0.3463
FW	258.1^{b}	269.9^{a}	248.2^{b}	267.4^{a}	257.5^{ab}	251.2^{b}	4.48	0.0061	0.0466	0.4839
WG	64.3^{b}	70.4^{a}	55.7^{c}	72.9^{a}	58.7^{b}	58.9^{b}	2.76	0.0025	0.0009	0.1721
ADG	0.92^{b}	0.99^{a}	0.79^{c}	1.04^{a}	0.83^{ab}	0.83^{b}	0.04	0.0058	0.0011	0.1892
FCR	8.6^{ab}	7.35^{b}	9.4^{a}	7.92^{c}	8.33^{b}	9.13^{a}	0.26	0.0094	0.0692	0.7427

[1]FI = Feed Intake, INW=Initial weight, FW=Final weight, WG=Weight gain, ADG=Average daily gain. FCR=Feed conversion ratio, [3]BRN = Boran, IRR=Iringa Red, SWT = Singida White, [4]SEM =Standard error of the mean, [6]Interaction of diets and strains.

3.3. Effects of Diets and Strains on Slaughter Characteristics of Bulls

The interaction effects between diet and strains on the slaughter characteristics of the experimental bulls were not significant (P<0.05) (Table 4). The mean values of the weight of full GIT and gut content (GC) were highest (P<0.05) on bulls fed on D1, while the lowest mean values were obtained from those fed on D3. The differences in mean FGIT and GC between the bulls fed on D2 and those on D3 were, however not significant (P>0.05). The mean effects of breed/strain on all the parameters assessed on slaughter characteristics were not significant (P>0.05) except for the internal organs (INO), where the average weight was higher (P>0.05) in BRN followed by the IRR and lowest in SWT.

Table 4. LSmeans on the effects of strains and diets on the slaughter characteristics of the bulls.

[1]Parameter (kg)	Diet			Strain			SEM	P values		
	D1	D2	D3	BRN	IRR	SWT		Diets	Strains	Diets x Strains
FGIT	27.0^{a}	23.4 ^{b}	23.3^{b}	24.5	24.5	24.7	0.52	0.0001	0.9405	0.4106
EGIT	7.06	6.89	7.3	7.09	7.18	7.0	0.42	0.7071	0.9781	0.0799
GC	19.9^{a}	16.5^{b}	15.9^{b}	17.4	17.2	17.7	0.61	0.0001	0.9042	0.7642
INF	3.8	4.57	4.36	4.65	4.18	3.85	0.28	0.1468	0.1697	0.8259
INO	5.9^{b}	6.9^{a}	6.1^{ab}	6.78^{a}	6.23^{ab}	5.93^{b}	0.17	0.0006	0.0054	0.3226
FEETS	5.73	5.80	5.76	5.92	5.63	5.73	0.20	0.9821	0.7018	0.2771

[1]FGIT = Full gastro intestinal tract, EGIT=Empty gastro intestinal tract, GC=Gut contents, INF =Internal fat, INO=Internal organ.

3.4. Effects of Diets and Strains on the Carcass Characteristics

Table 4 presents the effects of diets and breed/strains on the carcass characteristic of the slaughtered bulls. The highest values (P<0.05) of slaughter weight (SLW), empty body weight (EBW), hot carcass weight (HCW) and dressing percentage (DP) were shown by the bulls fed on D2 followed by those on D1. Bulls fed on D3 had poor performance, however the values of EBW, HCW and DP were similar (P>0.05) to those fed on D1. The highest mean values of carcass length

(CCL) and hind leg length (HLL) were obtained from bulls fed on D1, although the values were not different (P>0.05) from those shown by the bulls fed on D2. There were also significant strain effects, whereby Boran bulls showed the highest mean values of all carcass parameters compared to their counterparts. Nonetheless, the mean values of SLW, HCW, CCL,, chest depth (CD) hind leg length (HLL) and hind leg circumference (HLC) of BRN bulls were not different (P>0.05) from those of IRR. The bulls of Singida White produce the lowest (P<0.05) values for all the parameters assessed on carcass characteristics. There was no interaction effect (P>0.05) between the dietary treatments and the breed/strains for all the parameters measured on the carcass characteristics.

Table 5. *LSmeans on the effects of diets and strains on the carcass characteristics of the bulls.*

[1]Parameter	Diet			Strain			SEM	P values		
	D1	D2	D3	BRN	IRR	SWT		Diets	Strains	Diets x Strains
SLW	254.3^{b}	268.5^{a}	246.1^{b}	264.5^{a}	255.1^{ab}	259.4^{b}	4.40	0.0063	0.0036	0.5294
EBW	238.1^{ab}	253.4^{a}	232.2^{b}	250.0^{a}	240.2^{b}	233.5^{b}	0.47	0.0001	0.0442	0.7642
HCW	131.5^{ab}	140.8^{a}	125.7^{b}	138.2^{a}	130.4^{ab}	129.3^{b}	2.42	0.0004	0.0250	0.5133
DP	51.7^{b}	52.4^{a}	51.1^{b}	52.2^{a}	51.1^{b}	51.8^{b}	0.35	0.0288	0.0471	0.6518
CCL	97.7^{a}	98.5^{a}	96.2^{b}	99.8^{a}	97.2^{bc}	95.4^{c}	0.60	0.0291	0.0001	0.8515
CD	53.2	55.0	53.6	55.6^{a}	53.7^{ab}	52.5^{b}	0.67	0.1399	0.0085	0.5448
HLL	63.24^{a}	59.43^{a}	61.8^{b}	65.0^{a}	59.7^{a}	59.7^{b}	0.68	0.0317	0.0005	0.7596
HLC	97.02^{a}	96.52^{b}	91.1^{c}	98.7^{a}	93.8^{a}	92.1^{b}	1.79	0.0467	0.0363	0.2433

[1]SLW = Slaughter weight, EBW=Empty body weight, HCW= Hot carcass weight, DP=Dressing percentage, CCL=Carcass length, CD=Chest depth, HLL=Hind leg length, HLC=Hind leg circumference.

3.5. Effects of Diets and Strains on the Economic Analysis

Table 6 shows the effects of diet and strains on the economic analysis of finishing bulls in the feedlot. Results shows the average cost of purchasing bulls were not different (P>0.05) between the dietary treatments and strains (P<0.05). The highest cost of feeds was shown by the bulls fed on D1 while the lowest cost was shown on those fed on D3. The highest total variable cost was shown by the bulls fed on D3. The highest gross margin was obtained from the bulls fed on D2 and Boran bulls followed by Iringa Red.

Table 6. *Lsmeans of the effects of diets and strains on the economic analysis of finishing bulls in feedlot (Tshs 1x10^{6}).*

Parameters	Diet			Strain			SEM	P values		
	D1	D2	D3	BRN	IRR	SWT		Diets	Strains	Diets x Strains
Purchase of bulls	0.58	0.58	0.60	0.58	0.60	0.58	0.096	02554	0.3377	0.3463
Feeds cost	0.24^{a}	0.23^{b}	0.21^{c}	0.24^{a}	0.22^{b}	0.22 ^{b}	0.0013	0.0001	0.0001	0.345
Total variable cost	0.92^{ab}	0.91^{a}	0.96^{c}	0.96	0.95	0.95	0.095	0.0010	0.0548	0.3463
Revenue	1.39^{ab}	1.49^{a}	1.34^{b}	1.47^{a}	1.39^{ab}	1.38^{b}	0.0242	0.0002	0.0002	0.4942
Gross margin	0.44^{ab}	0.53^{a}	0.43^{b}	0.51^{a}	0.44^{b}	0.43^{b}	0.020	0.0008	0.0010	0.3134

4. Discussion

Among the formulated diets used in this study, D2 contained the highest values for ME and CP contents due to the inclusion of cassava meal, maize bran, and molasses, both of which have relatively high levels of ME contents while the sunflower seed cake which used as the main source of protein feed to all diets contain the highest value of CP. The combination of cassava meal with other feed ingredients of high nutritive value increases the live weight of feedlot bulls from 199.5 to 269.5 kg. This shows that among tested diets D2 is the best formulation that can be used for fattening bulls in feedlots. The observed 15.5 g/kg CP content in D2 is within the range of the CP required for fattening bulls in feedlots, [18]. The lowest weight gain of 57.6 kg obtained from D3 diet was due to the inclusion of rice polish, which has the lowest energy contents compared with other feed ingredients used in this experiment. This observation was also revealed in the study conducted by Asimwe in 2016 [13]. The highest ether extract was observed in D1, which was the control diet, and was attributed to the inclusion of maize bran and sunflower seed cake. The ME and CP contents of the diets used in this experiment were within the range of 10–11.6 MJME/kgDM and 110–130 g/kgDM, respectively, recommended by Rutherglen and NRC 2000, for fattening beef cattle [18]. The relatively highest feed intake, weight gain, average daily gain, and lowest values of feed conversion ratio observed in bulls fed on D2 are attributed to the inclusion of the higher levels of energy and protein feed ingredients compared to other diets. Research shows that bulls fed on a diet containing high nutritive values and palatability have a tendency to have the highest feed intake and growth performance [19]. The values of feed intake shown in D2 were more-or-less the same as the values obtained by Kimirei et al. [7], due to the inclusion of molasses and maize bran in the diet, as revealed in other studies [20, 21].

The values for feed intake of 7.00 kg/per head/day and weight gain of 70.4 kg obtained for the whole finishing period of 80 days obtained from this study were slightly the same as those obtained by Silvestre 2019 [22]. With regards to strains Boran showed the highest feed intake compared to Iringa red and Singida White due to having the largest body frame size. [23]. The average daily body gain of 0.99 kg shown by bulls fed on D2 was higher than the 0.92 reported by Asimwe. [13]. The observed lower final weight, weight gain, and average daily gain of about 248.2 kg, 55.7 kg, and 0.79 kg shown on bulls fed on D3 compared to other dietary treatments were associated with the low nutritive value of D3 due to the inclusion low-nutrient feeds in the diet. The value of the full gastro-intestinal tract of 27.1 kg obtained from this study was higher than that obtained by Gebremariam et al. [24] The highest values of the full gastro-intestinal tract shown in D1 were associated with the palatability of the diet, since D1 contained molasses and maize bran, which both have high palatability, leading bulls fed on D1 to have higher intake than in D2 and D3.

The bulls observed highest weight gain and internal organ weight in bulls fed on D2 compared to those fed on D1 and D3 could be associated with the differences in nutrient contents of the diets. Past research showed that large breeds of cattle produce heavier carcass weights and internal organs than small breeds [25]. The values of slaughter weight (268.5 kg), weight gain (140.2 kg), and empty body weight (253.4kg) observed in Boran bulls fed on D2 were higher than those slaughter weight (241kg), carcass weight (127kg), and empty body weight (227kg) reported by Mwilawa [26] on the same breed. These difference could be associated with the efficiency of utilization of the energy and protein in the formulated diets as similarly noted by Moloney et al. [27]. The mean value of dressing percentage obtained from the present study was slightly higher than that obtained from other studies [24] which could again attributed due to higher energy and protein intake by the bulls, which increases carcass weight and hence dressing percentage [28]. From the strain difference, the highest values of HLL (99.8 cm), CD (55.6 cm) HLL (65.0 cm) and HLC (98.7cm) were shown on Boran bulls, followed by Iringa red, and the lowest values were shown on Singida white bulls. This variation was associated with the breed difference between Boran and TSHZ. Boran cattle have the highest performance when supplemented with local feed resources compared to TSHZ cattle. This observation was also revealed by Bayssa 2021 [29]. The highest values of carcass length, hind leg length, circumference, and chest depth shown from bulls treated with D2 were more-or-less the same as those obtained by Asimwe [13], this could be due to high energy and protein intake above the maintenance requirement of animals involved, which increased growth rate and muscle turnover [30].

The observed highest total revenue could be associated with the highest carcass weight obtained from Boran bulls compared to their counterparts. The lowest total revenue and total variable cost observed in Singida White were due to the low final weight obtained at the end of the experiment. The lowest revenues shown in bulls fed on D3 were associated with the poor feed ingredients used in formulating the diet. (D3) contained 33% rice polish, which has low digestibility due to its high fiber and silica contents, which impair digestibility in the rumen and therefore slow the growth rate of bulls [31]. The highest total revenue and gross margin shown in bulls fed on D2 were associated with the high weight gain observed in bulls fed on D2. A study by Cowley [32] revealed that a diet with high nutrient contents increases the live weight of bulls in the feedlot and hence increases the gross margin.

5. Conclusion

Finishing Tanzania Short Horn Zebu cattle using local available feeds resources improves weight gain and carcass yield. D2 diet, which contained Cassava meal as the main energy source, produced animals with high mean values for weight gain, carcass weight and gross margin compared to

other formulated diets. Iringa red strain had feedlot performance comparable to that of Boran and therefore livestock keepers with focus on high growth performance and improved carcass traits should opt for this strain especially when fed on Cassava meal based feedlot diets. Further study should be extended to other strains of TSHZ to be fattened to increase the pools from which livestock keepers in various agro-ecological zones can select suitable animals for feedlot finishing in a cost effective way.

Author Contributions

Khatibu Abdallah Salum: Formal Analysis, Methodology, Validation, Visualization, Writing – original draft editing

Germana Henry Laswai: Formal Analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – review & editing

Daniel Elia Mushi: Data curation, Formal Analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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