EFFECT OF DIETARY SUPPLEMENTATION OF YEAST (*Saccharomyces cerevisiae)* ON GROWTH PERFORMANCE OF CROSSBRED HEIFERS

Chandrika Hazarika[1], Dulal Chandra Mili[1], R.J. Deka[1], Purabi Kaushik[2] , Nanda Kumar Roy[1], Poonam Das[1] Arup Deka[1] and Prerana Das[3]

1. Department of Livestock Production and Management CVSc., A.A.U.,Khanapara, Guwahati-22
2. Department of LFC, C V Sc, Khanapara
3. Department of Veterinary Physiology , CVSc., A.A.U.,Khanapara, Guwahati-22

Corresponding Author: Dr Purabi Kaushik, purabi.kaushik@aau.ac.in, Mobile no : 08811830761, ORCID No: https://orcid.org/0000-0003-1447-033X

ABSTRACT

The aim of the experiment was to investigate the effect of dietary supplementation of yeast *Saccharomyces cerevisiae* on the growth performance of crossbred heifers. A total of eighteen (18) crossbred heifers, above 1 year of age (16-18 months) with similar body weights were selected for the experiment. The herd was divided into three groups, each consisting of 6 animals. The experimental groups were termed as control (T_0), Treatment 1 (T_1) and Treatment 2 (T_2). The heifers of the experimental groups were individually fed a basal diet that consisted of a concentrate ration and roughages along with supplementation of 1.5gm/animal/day of dry yeast powder in T_1 and 3gm/animal/day of dry yeast powder in T_2 group respectively for a period of 90 days . The average initial and final body weight at 6th fortnight of the heifers were found to be 188.18 ±1.07 , 188.32 ±0.89 . 188.61 ±0.79 kg and 216.41 ±1.18, 218.55 ±1.19 and 220.65 ±1.33 kg in T_0, $T_1$and T_2 groups respectively. An increase of 28.23, 30.23 and 32.04 kg of body weight was in the respective groups. Analysis of variance of data did not imply any significant difference (P>0.05) of body weight and its interaction of the heifers in the experimental groups. The body weights of the heifers in all experimental groups increased linearly from 1st to 6th fortnight.

The average mean daily body weight gain in T_0, T_1 and T_2 were found to be 0.33 ± 0.04, 0.34 ±0.01, 0.35 ± 0.01kg in the 1st fortnight and 0.31 ± 0.05, 0.36 ±0.02 and 0.39 ±0.02 kg respectively in the 6th fortnight. The overall mean gain in

daily body weight was observed to be 0.31 ± 0.03kg in T_0 group, 0.35 ± 0.06kg in T_1 and 0.36 ± 0.07kg in T_2 group. The analysis of variance results showed that the mean average daily weight gain in T_1 and T_2 groups were significantly higher than T_0. The results of one way analysis of variance showed that the average daily gain (ADG) to be significantly high ($P<0.05$) in T_1 and T_2 groups compared to T_0 from 4^{th} to 6^{th} fortnight. The overall mean fortnightly gain in body weight was significantly high ($P<0.05$) in T_1 (4.94± 0.12kg) and T_2 (5.31 ± 0.10 kg) groups as well as compared to T_0 group(4.56 ± 0.04kg). With respect to individual fortnights, the average body weight gain was found to be higher in T_1 and T_2 groups than T_0 group from 4^{th} to 6^{th} fortnight.

The initial measurements of the body conformation traits in T_0, T_1 and T_2 respectively were found to be 110.49±0.67, 110.89±0.42, 112.16±0.31 cm with respect to body length of heifers, 135.23±0.34, 135.45±0.21 and 135.52±0.16 cm with respect to heart girth and 107.51±0.21 ,107.95±0.25 and 108.51± 0.21cm with respect to height at wither and the final conformation traits of body length, hearth girth and height at wither were respectively recorded as 122.22±0.47 , 122.32±0.26 and 124.46±0.40 cm in T_0, T_1 and T_2 respectively , 139.18±0.22 , 139.61±0.21 and 140.15±0.31 cm in T_0, T_1 and T_2 respectively and 117.24±0.31 , 117.67±0.21 and 118.11±0.22 cm in T_0, T_1 and T_2 respectively. The overall average values of the body conformation traits (cm) in T_0, $T_1$and T_2 groups were found in accordance as 116.60±0.27 cm, 116.76±0.29 cm and 117.66±0.24 cm for body length, 136.96±0.12 , 137.29±0.99 , 137.69±0.13 cm for heart girth and 112.04±0.22 , 112.51±0.20 and 113.17±0.21 cm for height at wither . Increase in linear body measurements from 1^{st} fortnight to 6^{th} fortnight along with body weight was observed in all the three parameters. Analysis of data on body conformation traits showed no significant ($P>0.05$) difference in body length, hearth girth and height at wither. Also, all the parameters were seen to been higher in yeast supplemented group compared to control group. Further, correlation of the body measurements with body weight were studied and it was found that the linear body measurements were highly correlated ($P<0.01$) with body weight. The coefficient of correlation (r) of body length with body weight were found as 0.832, 0.907, 0.838 in T_0, T_1 and

T_2 respectively. With respect to heart girth, the coefficient of correlation with body weight was found to be 0.928, 0.931, 0.929 in T_0, T_1 and T_2 respectively and the height at wither was found to be correlated to body weight as 0.915, 0.812 and 0.886 in T_0, T_1 and T_2 respectively.

The mean daily feed intake was found to be 4.37 ± 0.03, 4.39 ± 0.02 and 4.42 ± 0.02 kg/day in the 1st fortnight and 4.91 ± 0.03 , 4.93 ± 0.02 and 4.95 ± 0.03 kg/day in the 6th fortnight in T_0, T_1 and T_2 respectively. The overall mean daily feed intake was found to be 4.66 ± 0.03, 4.68 ± 0.03 and 4.72± 0.02 kg/day in T_0, T_1 and T_2 respectively. An increase in daily feed intake was observed successively in each fortnight. However, the results of the analysis of variance showed no significant ($P>0.05$) difference amongst the different experimental groups.

With respect to the parameter of feed conversion efficiency, T_1 and T_2 showed better FCE ratio compared to T_0. The FCE found in T_0, T_1 and T_2 respectively in the 1st fortnight was 12.04 ±0.21, 12.22 ±0.30 and 11.58 ±0.35 and 12.03 ±0.32, 10.93 ±0.25 and 10.28 ±0.23 respectively in the 6th fortnight. The overall mean FCE observed in the three groups were 12.18 ±0.08, 11.45±0.22 and 10.93 ±0.19 in T_0, T_1 and T_2 respectively. Results of analysis of variance revealed a highly significant ($P<0.01$) effect of supplementation of *S.cerevisiae* on the feed conversion efficiency of the experimental animals (T_1 and T_2 groups). A post-hoc test was further conducted and the results revealed that the FCE in T_2 and T_1 groups was significant from 3rd fortnight to 6th fortnight compared to the heifers of T_0 group.

Key words: Yeast (*Saccharomyces cerevisiae)*, Growth Performance, Crossbred Heifers

INTRODUCTION

Livestock is also one of the major sources of livelihood for the rural population of Assam. Here, cattle rearing are a part of the traditional heritage of the state as well as contributing to its sustainable agrarian economy. As per the 20th Livestock Census, 2019, the total livestock population of Assam is 18.09 million, out of which 10.51 million is cattle, which is an indication to the importance of cattle in the socio-economic life of rural Assam. Cattle in these rural areas is the most significant contributor to Assam's milk

production but their productivity rates and growth performance indices are very poor when compared to other developed parts of India, which is a major cause for concern and requires immediate attention. *Saccharomyces cerevisiae* is a widely used feed additive in animal rations. It is used in the form of active dry yeast and the microorganism belongs to the family of facultative anaerobes. It intakes oxygen and as a result is conducive in maintaining the anaerobic environment in the rumen. *Saccharomyces cerevisiae* is also found to provide growth factors, including organic acids, B vitamins and amino acids that stimulate microbial growth in the rumen, thereby indirectly stabilizing ruminal pH (Chaucheyras-Durand *et al*., 2006). A potential improvement in the performance of dairy heifers fed on yeast cultures as feed additives enhances the performances of the dairy heifers when they grow up to a potential cow. Thus, it was hypothesized that the inclusion of *Saccharomyces cerevisiae* culture into their diets might accelerate consumption of dry feed and improve animal health. Considering the favorable effects of incorporating yeast culture as feed additives in the ruminant's diet, the present research problem has been undertaken wherein the effect of dietary supplementation of yeast (*Saccharomyces cerevisiae*) on growth performance of crossbred heifers is studied with the objective to study the growth performance, feed intake and the economy involved of crossbred heifers in supplemented dose rate of 1.5gm/animal/day and 3gm/animal/day in two treatment groups (T_1 and T_2) respectively along with a control group.

MATERIALS AND METHODS

A total of eighteen crossbred (Jersey X Assam Local) dairy heifers of age above 1 year were selected (16-18 months of age), from ILF(C), CVSc, AAU, Guwahati-22 for the experiment. All the animals were conditioned for a period of one month before the start of the experiment. During this period, deworming of the animals was done before the commencement of the feeding trial. After the conditional period, the heifers were randomly divided into three groups viz. To (Control), T_1(Treatment) and T_2 (Treatment). Each of the groups consisted of six animals as follows-

TABLE 1 : DISTRIBUTION OF HEIFERS IN DIFFERENT TREATMENT GROUPS.

Groups	Identification Number	Body weight (Kg)
Control (T_0)	131/43	186.32
	126/52	188.61
	136/40	185
	112/62	191.43
	187/36	186.21
	162/64	191.56
Average ± SE		188.18 ±1.07
Treatment (T_1)	138/57	187.24
	151/45	185.12
	149/61	188.38
	139/59	191.51
	103/21	187.07
	171/90	190.6
Average ± SE		188.32 ±0.89
Treatment (T_1)	149/58	191.30
	137/46	190.21
	137/56	186.02
	147/49	187.5
	101/41	188.04
	150/22	188.60
Average ± SE		188.61 ±0.81

DESIGN OF THE EXPERIMENT

After the conditioning period was over, the selected 18 crossbred heifers were divided into three groups of six animals each as uniformly as possible with regard to age and body weight.

Three nutritional treatments were used in a complete randomised design for the three groups of animals as per the following schedule.

$T_{0\ (Control)}$	Standard conventional feeding system without the addition of dry yeast powder.
$T_{1\ (Treatment)}$	Fed supplemented with 1.5gm/animal of dry yeast powder
$T_{2(Treatment)}$	Feed supplemented with 3.0 gm/animal of dry yeast powder.

FEEDING TREATMENT OF EXPERIMENTAL HEIFERS

The heifers of all the three groups namely- T_0 (Control), T_1 (Treament1), T_2 (Treatment 2) groups were fed a basal diet consisting of a concentrate mixture and roughages whereas roughages comprised of Para grass (*Brachiaria mutica*) and paddy straw. The concentrate ration consisted of Maize (25 parts).Wheat Bran (20 parts) DO Rice Bran (12 parts), Rice Polish (10 parts) GNC (18 parts) Soyabean meal (12 parts) Mineral Mixture (2 parts) and Iodised salt (1 parts) The concentrate ration consisted of 16% DCP and 70% TDN respectively, as per the requirements of ICAR 2013. The feeds of the treatment groups T_1 and T_2 were supplemented with 1.5 gm/animal and 3gm/animal of dry yeast powder, respectively.

PARAMETERS STUDIED AND METHODOLOGY

The following observations were recorded during the period of experiment.

Productive parameters

1. Fortnightly changes in body weight (kg)
2. Fortnightly changes in linear body measurements viz - height at wither, heart girth and body length (cm)
3. Daily feed intake (kg/day)
4. Feed conversion efficiency
5. Cost of feeding

Fortnightly changes in body weight (kg)

The fortnightly changes in body weights of the experimental heifers were individually recorded on a digital platform balance (in kg) of maximum 500 kg capacity before offering them feed and water. The respective body weight gain of the heifers were worked out by subtracting the body weight of the previous fortnight from the present fortnight and expressed in kg.

Fortnightly changes in linear body measurements

Body conformation traits that were evaluated in this experiment were body length, heart girth and height at wither. The measurement was taken at the start of the experiment and were calculated fortnightly. Every animal was made to stand upright on its four legs on levelled floor to ensure correct measurements. The measurements were taken with a measuring tape in centimetres (cm).

Body Length (cm)

The body length was measured by a measuring tape on either side of the animal from the point of shoulder to the point of pin bone and the average was recorded in centimetres.

Heart girth (cm)

The heart girth was measured with the help of a measuring tape by taking the circumference of the body over the chest of the heifer immediately behind the shoulder, forelegs and hump .

Height at wither (cm)

To calculate this parameter, the animal was made to stand on a levelled floor with its head in stable position and then the height was recorded as the distance from the ground to the highest point of withers on either side of the body by a wooden measuring stick. After that the average was calculated and recorded in centimetres.

Daily feed intake (kg/day)

The daily feed offered and the residue left after 24 hours was weighed and measured and feed consumption were calculated and expressed on the DM (kg) basis daily.

Feed Conversion Efficiency

To calculate this parameter, the dry matter consumption was taken into account along with per kg live weight gain was estimated fortnightly for the different groups separately till the sixth fortnight .The feed conversion efficiency was calculated by using the following formula .

$$FCE = \frac{\text{Feed consumed (kg)}}{\text{Body weight gain (kg)}}$$

Cost of feeding (Rs)

The costs of feeding the heifers were calculated by taking into account the cost of concentrate ration, green grass and paddy straw. The prevailing price list of the feed ingredients of price list of the College of Veterinary Science, Khanapara, Guwahati-781022 was used to calculate the per kg cost of concentrate feed. The prices were Rs.30.60 per kg concentrate, Rs. 1.5 Per kg green grass and Rs. 4.0 Per kg. paddy straw. Cost of housing, labour and others were not calculated which were common to all the experimental groups.

RESULTS AND DISCUSSIONS

CHEMICAL COMPOSITION OF FEEDS AND ESTIMATED NUTRITIVE VALUES OF COMPOSITE RATION

The crude protein content of concentrate mixture was 16.00%, dry matter content was 87.25%, crude fiber 7.73%, ether extract 2.97%, NFE 61.91%, total ash 6.87% and organic matters of the concentrate ration was 91.78% respectively. The percentage of crude protein

in paddy straw was 2.53%, dry matter content was 90.1%, crude fiber 28.72%, ether extract 2.17%, NFE 54.61%, total ash 12.51% and organic matter of the paddy straw was 88.03% respectively . The percentage of crude protein in para grass was 10.30%, dry matter content was 20.6%, crude fiber 20.81%, ether extract 2.31%, NFE 50.83%, total ash 9.25% and organic matter of the para grass was 90.25% respectively as presented in Table 2.

TABLE 2: PERCENTAGE CHEMICAL COMPOSITION OF CONCENTRATE MIXTURE AND OTHER FEED INGREDIENTS (ON PER CENT DM BASIS)

Components	Concentrate Mixture	Para Grass	Paddy straw
Dry matter	87.25	20.6	90.1
Organic Matter	91.78	90.25	88.03
Crude Protein	19.17	10.30	2.53
Ether extract	2.97	2.31	2.17
Crude fibre	7.73	26.81	28.72
Total ash	61.91	50.83	54.61
NFE	6.87	9.25	12.51

PRODUCTIVE PARAMETERS

Fortnightly changes in body weight

The average fortnightly changes in body weight (kg) along with results of analysis of variance of crossbred heifers in T_0, T_1 and T_2 groups are presented in Table 3 and Table 4 respectively.

The average body weight (kg) in heifers in T_0, T_1 and T_2 groups were recorded as follows- 188.18±1.07,188.32 ±0.89 and 188.61 ±0.79 kg at initial, 192.26 ±1.07, 192.46±1.08 and 192.86±0.93 kg at 1st ,197.56±1.07, 197.79±1.21 and 198.01±0.91 kg at 2nd , 202.21±1.14, 202.81±1.35 and 203.32±0.92 kg at 3rd ,206.88±1.20 , 207.98±1.22 ,and 208.69±1.63 kg at 4th , 211.59±1.14,213.19±1.27 and 214.16±1.18kg at 5th and 216.41±1.18, 218.55±1.19 and 220.65±1.33 kg at 6th fortnight.

The statistical analysis of variance of data revealed no significant difference ($P>0.05$) between the interaction of body weight and crossbred heifers in the T_0, T_1 and T_2 groups. A linear increase in body weight was observed from 1st fortnight to 6th fortnight. However, significant differences were observed in the fortnightly average values of body weight. ($P<0.01$).

The findings were supported by the experimental findings of Pandey and Agarwal (2001) who did not find significant differences in initial and final body weight of crossbred calves. Pinoz –Rodriguez *et.al*(2008) evaluated the impact on body weight of ruminants fed on diet supplemented with 1gm/day of *S.cerevisiae* and observed similar non significant results. Ghazanfar *et.al* (2015) also reported non significant increase in overall body weight. The experimental findings are also in agreement with the findings of Maa *et.al* (2021) where no significant difference of initial and final body weight was observed in between the animals of control (C0N) and test (ADY) groups. Mamouri *et al*. (2022) also observed non significant difference ($p>0.367$) in the initial and final body weight of fattening calves of control and treatment groups in a 147 day feeding trial.

Table 3 : AVERAGE (MEAN ±SE) OF BODY WEIGHT (kg) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnight	T_0	T_1	T_2	P-Value
Initial	188.18±1.07	188.32 ±0.89	188.61 ±0.79	0.765
1st	192.26 ±1.07	192.46±1.08	192.86±0.93	0.522
2nd	197.56±1.07	197.79±1.21	198.01±0.91	0.336
3rd	202.21±1.14	202.81±1.35	203.32±0.92	0.255
4th	206.88±1.20	207.98±1.22	208.69±1.63	0.180
5th	211.59±1.14	213.19±1.27	214.16±1.18	0.082
6th	216.41±1.18	218.55±1.19	220.65±1.33	0.271

Table 4: ANOVA OF AVERAGE BODY WEIGHT (kg) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	165.686	2	82.84	11.183	0.723^{NS}
Fortnights	12916.007	6	2152.668	290.596	0.000**
Interaction	53.843	12	4.487	0.606	0.833^{NS}
Error	777.816	105	7.408		
Total	13913.352	125			

^{NS}Non- significant ($P>0.05$) **Highly significant ($P<0.01$)

Fortnightly gain in body weight

The average fortnightly gain in body weight (kg) in T_0, $T_1$and T_2 groups has been represented along with the results of analysis of variance of weight gain in Table 5. Table 6 respectively.

The overall mean values of fortnightly gain in body weight are 4.56 ±0.04, 4.94 ±0.12 and 5.31 ±0.10 in T_0, $T_1$and T_2 groups respectively.. The respective fortnightly mean body weight gains in T_0, T_1 and T_2 groups were 4.08±0.06, 4.14±0.33 and 4.25±0.25 kg in the 1st fortnight, 4.63±0.11. 4.79±0.17 and 5.01±0.17kg in the 2nd fortnight, 4.65±0.07, 5.02±0.36 and 5.31±0.28 kg in the 3rd fortnight, 4.67±0.07, 5.17±0.04 and 5.37±0.15kg in the 4th fortnight, 4.71±0.05, 5.21±0.05 and 5.47±0.19 kg in the 5th fortnight , 4.82±0.08, 5.36±0.31 and 6.49±0.40 kg in the 6th fortnight

Statistical analysis revealed significant ($P<0.01$) difference between the T_0 group with T_1 and T_2 groups from 4th fortnight to 6th fortnight leading to a significant difference in overall mean ($P<0.01$) between T_0 group with T_1 and T_2 groups. The fortnightly average values of body weight varied significantly ($P<0.01$).

TABLE 5 : AVERAGE (MEAN ±SE) OF BODY WEIGHT GAIN (kg) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnights	T_0	T_1	T_2	P- value
1	4.08 ± 0.06	4.14 ± 0.33	4.25 ± 0.25	0.067
2	4.63±0.11	4.79±0.17	5.01±0.17	0.315
3	4.65±0.07	5.02±0.36	5.31±0.28	0.447
4	$4.67±0.07^a$	$5.17±0.04^b$	$5.37±0.15^b$	0.051^*
5	$4.71±0.05^a$	$5.21±0.05^b$	$5.47±0.19^b$	0.034^*
6	$4.82±0.08^a$	$5.36±0.31^b$	$6.49±0.40^b$	0.016^*
Overall	$4.56±0.04^a$	$4.94±0.12^b$	$5.31±0.10^b$	0.003

Means with similar superscripts in a row don't differ significantly ($P>0.05$)

TABLE 6 : ANOVA OF AVERAGE BODY WEIGHT (kg) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	10.132	2	5.050	17.792	0.003*
Fortnights	2.556	5	0.510	11.795	0.001**
Interaction	7.800	10	0.780	2.740	0.005*
Error	25.617	90	0.285		
Total	46.094	107			

*= Significant (P<0.05) **=Highly significant (P<0.01)

Daily body weight gain (kg)

The average fortnightly gain in body weight (kg) in T_0, $T_1$and T_2 groups has been represented along with the results of analysis of variance of weight gain in Table 7 and Table 8 respectively.

The overall mean values of daily gain in body weight are 0.31 ±0.03, 0.35 ± 0.06 and 0.36± 0.07 in T_0, $T_1$and T_2 groups respectively. The mean gain in body weight in different fortnights in T_0, $T_1$and T_2 groups were 0.33 ± 0.04, 0.34 ±0.01 and 0.35 ± 0.01kg in the 1st fortnight, 0.31 ±0.07, 0.34 ±0.12 and 0.35 ±0.01 kg in the 2nd fortnight, 0.32 ±0.05, 0.35 ±0.02 and 0.35 ±0.01kg in the 3rd fortnight, 0.31 ±0.05, 0.36 ±0.01 and 0.36 ±0.01kg in the 4th fortnight , 0.31 ±0.03, 0.35 ±0.01 and 0.36 ±0.01kg in the 5th fortnight and 0.31 ± 0.05, 0.36 ±0.02 and 0.39 ±0.02 kg respectively in the 6th fortnight, respectively.

Statistical analysis of variance revealed significant (P<0.01) difference between the T_0 group with T_1 and T_2 groups from 4th fortnight to 6thfortnight leading to a significant difference in overall mean (P<0.01) between T_0 group with T_1 and T_2 groups. The present findings were found to be in agreement with the experimental results of Panda *et al.* (1995) who observed significant increase (P<0.05) in gain of body weight by supplementing 2gm/kg of *Saccharomyces cerevisiae* in the basal diets of crossbred calves. Kumar *et al.* (2011) also reported similar significant findings (P<0.05) in buffalo bull calves fed on diets supplemented with yeast culture compared to control. The findings of Ghazanfar *et al.* (2015) also observed similar significant results (P<0.05) in average daily weight gain when the basal diet of the heifers were supplemented with 5gm/animal/day of *Saccharomyces*

cerevisiae in the 120 day feeding trial. Yasmin *et al*. (2021) concluded similar findings on studying the influence of probiotics in the growth performance of growing cattle. A significant rise in average daily weight gain was also observed by Cai *et al*. *(2021)* on studying inclusion of *S.cervisiae* in the diets of heat stressed goats. The experimental findings are also consistent with the results of Mamouri *et.al* (2022) who found highly significant (P<0.0001) increase in daily body weight gain of HF calves fed supplemented feed with live *S. cerevisiae* in a 147 day feeding trial.

TABLE 7 : AVERAGE (MEAN ±SE) OF DAILY BODY WEIGHT GAIN (kg) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnights	T_0	T_1	T_2	P- value
1	0.33 ±0.04	0.34 ±0.01	0.35 ±0.01	0.822
2	0.31 ±0.07	0.34 ±0.12	0.35 ±0.01	0.109
3	0.32 ±0.05	0.35 ±0.02	0.35 ±0.01	0.295
4	0.31 ±0.03^{a}	0.36 ±0.01^{b}	0.36 ±0.01^{b}	0.036*
5	0.31 ±0.03^{a}	0.35 ±0.01^{b}	0.36 ±0.01^{b}	0.042*
6	0.31 ±0.05^{a}	0.36 ±0.02^{b}	0.39 ±0.02 ^{b}	0.011*
Overall	0.31 ±0.03^{a}	0.35 ±0.06^{b}	0.36 ±0.07^{b}	0.04*

Means with similar superscripts in a row donot differ significantly (P>0.05)

TABLE 8 : ANOVA OF AVERAGE DAILY BODY WEIGHT (kg) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	0.051	2	0.025	21.744	0.004*
Fortnights	0.003	5	0.001	13.849	0.000**
Interaction	0.016	10	0.002	2.740	0.005*
Error	0.105	90	0.001		
Total	0.175	107			

*= Significant (P<0.05) **=Highly significant (P<0.01)

Fortnightly changes in body measurements

Body length (cm)

The average values of the body length initially were recorded as 110.49±0.67,110.89±0.42 and 112.16 ±0.31 cm in T_0, T_1 and T_2 respectively, The overall mean of the parameter were recorded as 116.60 ±0.27, 116.76 ±0.29 and 117.66 ±0.24 in T_0, T_1 and T_2 respectively. The mean body length of the experimental animals in different fortnights were recorded as- 114.30 ± 0.25, 113.03 ±0.43 and 114.61 ±0.26 cm in the 1st fortnight, 115.13 ±0.42 , 115.31 ±0.42 and 115.97 ±0.42 cm in 2nd fortnight, 116.21 ±0.43, 116.84 ±0.26 and 116.40 ±0.31 in the 3rd fortnight,117.70 ±0.43, 118.11 ±0.43 and 118.38 ±0.37 in the 4th fortnight, 120.21 ±0.43, 120.65 ±0.43 and 121.65 ±0.43 in the 5th fortnight and 122.22 ±0.47, 123.32 ±0.26 and 124.46 ± 0.40 in the 6th fortnight, in T_0, T_1 and T_2 groups respectively (Table 9)

The analysis of variance (Table 10) shows no significant difference of body from 1st fortnight to the 6th fortnight. The fortnightly average values of body length varied significantly ($P<0.01$). The present findings are in close agreement with the experimental findings of Lascano *et al.* (2009) who observed non significant increase in skeletal body measurements that included body length measurements on conducting a 133 day feeding trial on 32 holstein heifers by supplementing 1gm/kg of yeast culture in their basal diets. Ghaznafar *et al.* (2015) reported similar findings on supplementing the daily diets of dairy heifers with 5gm/animal/day of *S. cerevisiae* for a period of 120 days. Agazzi *et al.* (2014) also reported the research findings to follow similar patterns.

Table 9 : AVERAGE (MEAN ±SE) OF BODY LENGTH(cm) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnight	T_0	T_1	T_2	P-Value
Initial	10.49 ± 0.67	110.89 ±0.42	112.16 ±0.31	0.616
1st	114.30 ±0.25	113.03 ±0.43	114.61 ±0.26	0.472
2nd	115.13 ±0.42	115.31 ±0.42	115.97 ±0.42	0.814
3rd	116.21 ±0.43	116.84 ±0.26	116.40 ±0.31	0.785
4th	117.70 ±0.43	118.11 ±0.43	118.38 ±0.37	0.682
5th	120.21±0.43	120.65 ±0.43	121.65 ±0.43	0.950
6th	122.22 ±0.47	123.32 ±0.26	124.46 ±0.40	0.250
Overall	116.60 ±0.27	116.76 ±0.29	117.66 ±0.24	0.896

Table 10 : ANOVA OF AVERAGE BODY LENGTH (cm) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	1.331	2	0.665	0.109	0.896^{NS}
Fortnights	1758.317	6	293.052	48.257	0.000^{**}
Interaction	41.679	12	3.473	0.571	0.860^{NS}
Error	637.633	105	6.072		
Total	2438.961	125			

^{NS}Non- significant (P>0.05) **Highly significant (P<0.01)

Heart girth

The average initial values of the heart girth in experimental heifers were found to be 135.23 ±0.34, 135.45 ±0.21 and 135.52 ±0.16 cm in T_0, T_1 and T_2 groups respectively. The mean measures of heart girth in the following fortnights has been found as 135.45 ±0.21 , 135.79 ±0.22, 136.91 ±0.24cm in the 1st fortnight, 135.89 ±0.34, 136.29 ±0.33, 136.43 ±0.25 cm in the 2nd fortnight, 136.99 ±0.21, 137.16 ±0.12, 137.53 ±0.24cm in the 3rd fortnight, 137.71 ±0.21 , 137.99 ±0.21 , 138.12 ±0.25 cm in the 4th fortnight, 138.32 ±0.22, 138.75 ±0.21, 139.23 ±0.30 cm in the 5th fortnight and 139.18 ±0.22, 139.61 ±0.21 and 140.15 ±0.31 cm in the 6th fortnight in T_0,T_1 and T_2 groups respectively. The overall mean of measurements in heart girth were found to be 136.96 ±0.12, 137.29 ±0.99 and 137.69 ±0.13 cm in T_0,T_1 and T_2 groups respectively.

Analysis of variance as shown in Table 12 showed no significant difference in the overall values of hearth girth. A linear increase in the values of hearth girth is seen from the 1st fortnight to 6th fortnight, a highest increase in measurement was recorded in T_2 group compared to T_1 and T_0 groups. The fortnightly average values of hearth girth varied significantly (P<0.01).

The average fortnightly changes in chest girth and the results of analysis of variance of the experimental groups have been showed in Table 11 and Table 12 respectively. The present findings corroborated with the finding of Dharmasaree *et al.* (1991). Lascano *et al.*(2009) also observed non significant increase in heart girth measurements after conducting a 133 day feeding trial on 32 holstein heifers by supplementing 1gm/kg of yeast culture in their

basal diets. Ghazanfar *et al.* (2015) reported similar findings on supplementing the daily diets of dairy heifers with 5gm/animal/day of *S. cerevisiae* for a period of 120 days.

Table 11 : AVERAGE (MEAN ±SE) OF HEART GIRTH (cm) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnight	T_0	T_1	T_2	P-Value
Initial	35.23 ±0.34	135.45 ± 0.21	135.52 ±0.16	0.651
1st	135.45 ±0.21	135.79 ±0.22	136.91 ±0.24	0.821
2nd	135.89 ±0.34	136.29 ±0.33	136.43 ±0.25	0.531
3rd	136.99 ±0.21	137.16 ±0.12	137.53 ±0.24	0.315
4th	137.71 ±0.21	137.99 ±0.21	138.12 ±0.25	0.263
5th	138.32 ±0.22	138.75 ±0.21	139.23 ±0.30	0.286
6th	139.18 ±0.22	139.61 ±0.21	140.15 ±0.31	0.075
Overall	136.96 ±0.12	137.29 ±0.99	137.69 ±0.13	0.073

Table 12 : ANOVA OF AVERAGE HEART GIRTH (cm) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	20.358	2	10.179	2.828	0.073^{NS}
Fortnights	304.53	6	50.755	14.103	0.000^{**}
Interaction	25.145	12	2.095	0.582	0.852^{NS}
Error					
Total					

^{NS}Non- significant (P>0.05) **Highly significant (P<0.01)

Height at wither

The average initial values of the height at wither in experimental heifers were found to be 107.51 ±0.21, 107.95 ±0.25, 108.51 ±0.21 in T_0, T_1 and T_2 groups respectively. The mean measures of height at wither in the following fortnights has been found as 108.35 ±0.34, 109.22 ±0.25, 109.62 ±0.30 cm in the 1st fortnight, 110.49 ±0.24, 110.74 ±0.33, 111.32 ±0.16 cm in the 2nd fortnight, 112.59 ±0.21, 113.03 ±0.23, 113.25 ±0.16 cm in the 3rd fortnight, 113.43 ±0.33, 114.86 ±0.16, 115.57 ±0.22 cm in the 4th fortnight, 114.70 ±0.16, 115.13 ±0.34, 116.84 ± 0.30 cm in the 5th fortnight and 117.24 ±0.31, 117.67 ±0.21 and 118.11 ±0.22 cm in the 6th fortnight in T_0,T_1 and T_2 groups respectively. The overall mean

of measurements in chest girth were found to be 112.04 ±0.22 , 112.51 ±0.20 and 113.17±0.21 cm in T_0,T_1 and T_2 groups respectively (Table 13).

Analysis of variance as shown in Table 14 showed no significant difference in the overall values of height at wither. A linear increase in the values of height at wither is seen from the 1st fortnight to 6th fortnight, a highest increase in measurement was recorded in T_2 group compared to T_1 and T_0 groups. The fortnightly average values of height at wither varied significantly (P<0.01). The present experimental findings are in close agreement with the findings of Lascano *et al.*(2009) who observed non significant increase in height at wither on conducting a 133 day feeding trial on 32 holstein heifers by supplementing 1gm/kg of yeast culture in their basal diets. Ghazanfar *et al.* (2015) reported similar findings on supplementing the daily diets of dairy heifers with 5gm/animal/day of *S. cerevisiae* for a period of 120 days. Agazzi *et al.* (2014) also noticed the research findings to follow similar patterns.

Table 13 : AVERAGE (MEAN ±SE) OF HEIGHT AT WITHER (cm) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnight	T_0	T_1	T_2	P-Value
Initial	)7.51 ±0.21	107.95 ±0.25	108.51 ±0.21	0.089
1st	108.35 ±0.34	109.22 ±0.25	109.62 ±0.30	0.505
2nd	110.49 ±0.24	110.79 ±0.33	111.32 ±0.16	0.651
3rd	112.59 ±0.21	113.03 ±0.23	113.25 ±0.16	0.236
4th	113.43 ±0.33	114.86 ±0.16	115.57 ±0.22	0.082
5th	114.70 ±0.16	115.13 ±0.34	116.84 ±0.30	0.152
6th	117.24 ±0.31	117.67 ±0.21	118.11 ±0.22	0.651
Overall	112.04 ±0.22	112.51 ±0.20	113.17 ±0.21	0.761

Table 14 : ANOVA OF AVERAGE HEIGHT AT WITHER (cm) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	1.433	2	0.828	0.113	0.761^{NS}
Fortnights	1685.712	6	298.163	20.255	0.000^{**}
Interaction	43.798	12	3.423	0.571	0.772^{NS}
Error	673.163	105	6.726		
Total	2834.172				

^{NS}Non- significant (P>0.05) **Highly significant (P<0.01)

Correlation between body weight and body measurements

The correlation coefficient of body weight and body measurements are presented in Table 15. The value of coefficient of correlation between body weight and body length was found to be 0.832, 0.907 and 0.838 in T_0, T_1 and T_2 respectively. In terms of hearth girth, the coefficient of correlation was found to be 0.928, 0.931 and 0.929 respectively in T_0, T_1 and T_2 w.r.t. body length. The 'r' of hearth girth w.r.t body length was found to be 0.915, 0.812 and 0.886 in T_0, T_1 and T_2 respectively. Results of statistical analysis revealed that the body weight has highly significant ($P<0.01$) positive correlation with body length, hearth girth and height at wither . The findings are in agreement with the findings of Ozkaya and Bozkurt (2009), Vahora *et al.* (2012) and Lukuyu *et al.* (2016) who found close correlation of body conformation traits with body weight.

TABLE 15. CORRELATION COEFFICIENT OF BODY WEIGHT AND BODY MEASUREMENTS OF THE HEIFERS IN EXPERIMENTAL GROUPS

Body measurements	Correlation coefficient with body weight		
	T_0	T_1	T_2
Body length	0.832**	0.907**	0.838**
Hearth girth	0.928**	0.931**	0.929**
Height at wither	0.915**	0.812**	0.886**

**Highly significant ($P<0.01$)

Daily feed intake

The average daily feed intake and the results of analysis of variance of the experimental heifers during the research have been shown in Table 16 and Table 17.The average daily feed intake of the experimental animals in different fortnights are as follows 4.37 ±0.03, 4.39 ±0.02 and 4.42 ±0.02 kg/day in the 1st fortnight, 4.50 ±0.04, 4.52 ±0.02 and 4.55 ±0.02 kg/day in the 2nd fortnight, 4.64 ±0.02 , 4.66 ±0.03 and 4.68 ±0.02 kg/day in the 3rd fortnight, 4.73 ±0.03, 4.74 ±0.03 and 4.80 ±0.02kg/day in the 4th fortnight , 4.82 ±0.03, 4.85 ±0.03 and 4.92 ±0.02 kg/day in the 5th fortnight and 4.91 ±0.03, 4.93 ±0.02 and 4.95 ±0.03 kg/day in the 6th fortnight in T_0, T_1 and T_2 groups respectively. The overall mean of the daily feed intake kg/day in T_0 , T_1 and T_2 groups were found to 4.66 ±0.03, 4.68 ±0.03 and 4.72 ± 0.02 kg/day respectively.

Analysis of variance (Table 17) revealed no significant difference between the groups . However, a linear increase in daily feed intake was observed from 1st fortnight to 6th fortnight , The fortnightly average values of daily feed intake (kg /day) varied significantly ($P<0.01$). The present experimental findings were in corroboration with the findings of Panda *et al.* (1995) who found similar non significant increase on daily feed intake when the basal diet of experimental crossbred calves were supplemented with 2gm /head/day of *S.cerevisiae.* Moharrery *et al.* (2009) on investigating the impact of inclusion of *S.cerevisiae* on lambs @ 10gm/kg body weight and observed non significant increase in feed intake. Ghazanfar *et al.* (2015) supplemented *S.cerevisiae* at an amount of 5gm/head/day to crossbred heifers also observed similar results in support with the present findings. Srivastava *et al.* (2017) noticed similar non significant increase in dry matter intake on supplementing the diets to crossbred kids with probiotics. Similar non significant results in dry matter intake was observed by Gamal *et.al* (2019) on supplementing the diets of beef buffalo calves with 0.5g/day *S.cerevisiae* . Maa *et.al* (2021) on investigating the impact of inclusion of *S. cerevisiae* in the diets of beef-weaned calves found non significant results between the control and experimental groups. The experimental findings are also in corroboration with the results of Mamouri *et. al* (2022) where non significant increase in daily feed intake was observed between calves of control and treatment groups.

TABLE 16 : AVERAGE (MEAN ±SE) OF DAILY FEED INTAKE (kg/day) OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnight	T_0	T_1	T_2	P-Value
1st	4.37 ±0.03	4.39 ±0.02	4.42 ±0.02	0.486
2nd	4.50 ±0.04	4.52 ±0.02	4.55 ±0.02	0.396
3rd	4.64 ±0.02	4.66 ±0.03	4.68 ±0.02	0.241
4th	4.73 ±0.03	4.74 ±0.03	4.80 ±0.02	0.157
5th	4.82 ±0.03	4.85 ±0.03	4.92 ±0.02	0.072
6th	4.91 ±0.03	4.93 ±0.02	4.95 ±0.03	0.176
Overall	4.66 ±0.03	4.68 ±0.03	4.72 ±0.02	0.076

TABLE 17: ANOVA OF AVERAGE DAILY FEED INTAKE (kg/day) OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	0.047	2	0.023	2.79	0.076^{NS}
Fortnights	4.230	5	0.846	100.09	3.320^{**}
Interaction	0.040	10	0.0041	0.479	0.899^{NS}
Error	0.761	90			
Total	5.079	107			

^{NS}Non- significant (P>0.05) **Highly significant (P<0.01)

Feed conversion efficiency

The average feed conversion efficiencies and the results of analysis of variance of the experimental heifers during the research have been shown in Table 4.17 and Table 4.18. A bar diagram, representing the feed conversion efficiency of the experimental period has been shown on Fig 4.7

The average daily feed intake of the experimental animals in different fortnights are as follows 12.04 ±0.21, 12.22 ±0.30 and 11.58 ±0.35 in the 1st fortnight, 12.50 ±0.32, 11.96 ±0.41 and 11.39 ±0.11 in the 2nd fortnight, 12.13 ±0.25, 11.32 ±0.38 and 10.85 ±0.28 in the 3rd fortnight, 12.40 ±0.39, 11.42 ±0.32 and 10.70 ±0.24 in the 4th fortnight , 11.97 ±0.31, 10.83 ±0.25 and 10.78 ±0.17 in the 5th fortnight and 12.03 ±0.32 , 10.93 ± 0.25 and 10.28 ±0.23 in the 6th fortnight in T_0, T_1 and T_2 groups respectively. The overall mean of the feed conversion efficiency in T_0 , T_1 and T_2 groups were found to be 12.18 ±0.08, 11.45 ± 0.22 and 10.93 ± 0.19 respectively.

Analysis of variance (Table 19) revealed highly significant difference in the effect of supplementation of *S. cerevisiae* between the groups . A further Post – hoc test showed that FCE in T_2 and T_1 group from 3rd fortnight to 6th fortnight compared to T_0 group.

TABLE 18 : AVERAGE (MEAN ±SE) OF FEED CONVERSION EFFICIENCY OF THE HEIFERS IN T_0, T_1 AND T_2 GROUPS IN DIFFERENT FORTNIGHTS

Fortnights	T_0	T_1	T_2	P- value
1st	12.04 ±0.21	12.22 ±0.30	11.58 ±0.35	0.319
2nd	12.50 ±0.32	11.96 ±0.41	11.39 ±0.11	0.071
3rd	12.13 ±0.25^a	11.32 ±0.38^b	10.85 ±0.28^b	0.034*
4th	12.40 ±0.39^a	11.42 ±0.32^b	10.70 ±0.24^b	0.008*
5th	11.97 ±0.31^a	10.83 ±0.25^b	10.78 ±0.17^b	0.007*
6th	12.03 ±0.32^a	10.93 ±0.25^b	10.28 ±0.23^b	0.002*
Overall	12.18 ±0.08^a	11.45 ±0.22^b	10.93 ±0.19^b	0.004*

Means with similar superscripts in a row don't differ significantly (P>0.05)

TABLE 19 : ANOVA OF AVERAGE FEED CONVERSION EFFICIENCY OF THE HEIFERS IN EXPERIMENTAL GROUPS

Source of variation	Type III sum of squares	df	MS	F	Significance
Treatment groups	10.394	2	5.197	27.786	0.004*
Fortnights	12.141	5	2.429	4.584	0.000**
Interaction	5.248	10	0.524	0.990	0.457^{NS}
Error	47.70	90	0.530		
Total	93.49	107			

^{NS}= Non –significant *= Significant at (P<0.05) **= Highly significant (P<0.01)

The findings are in agreement with the experimental findings of Panda *et al.* (1995) that reported better feed conversion ratio in yeast supplemented group. Kumar and Reddy (2004) noticed considerable improvement in the feed conversion efficiency of crossbred heifers fed with yeast (*S.cerevisiae*) supplemented roughage based rations as compared to control group. Ghazanfar *et al.* (2015) also observed improved FCR on supplementing the diets of dairy heifers with *S.cerevisiae* . A similar pattern was seen in the experimental findings of Kumar *et al.* (2018). The significant findings are also similar to the experimental findings of Ahmad *et al* (2018) who observed efficient FCR on supplementing the diets of Murrah buffaloes with 24g/day *S.cerevisiae* for a period of 120 days. The significant experimental findings of FCE are also in agreement with the findings of Klopp *et.al* (2021) where S.cerevisie supplemented feed was fed to post weaned dairy calves and Maa

et.al(2021) where FCE of control and test groups of beef weaned calves showed significant difference (P>0.022).

CONCLUSIONS

Based on the findings of the present study, it might be concluded that supplementing the basal diets of heifers with yeast (*Saccharomyces cerevisiae)* had led to promising results in the treatment groups. The significant gain in body weight daily and fortnightly (P<0.05) along with increase in linear body measurements (P>0.05), the highly significant (P<0.01) improvement of FCE in the yeast supplemented groups and the linear increase of daily feed intake (P>0.05) leads to the conclusion that inclusion of *S.cerevisiae* in the basal diets of heifers has an encouraging influence in the growth of heifers . However, further research with more numbers of animals / heifers considering other environmental and physiological parameters for a longer period of study may be carried out for better understanding of the effect of yeast supplementation in the diets of heifers.

Conflict of Interest: There is no conflict of interest. All authors read and approved the final manuscript. The research was conducted following the guidelines of Institutional Animal Ethics Committee of Assam Agricultural University, Khanapara, Guwahati-781022, Assam, India vide memo no m770/GO/Re/S/03/CPCSEA/FVSC/AAU/IAEC/21-22/922 dtd 20.08.2022.

Acknowledgement: The authors are thankful to Department of Livestock Production and Technology, Assam Agricultural University, Khanapara-781022 to carry out the research work.

References:

20th Livestock Census (2019). Government of India, Ministry of Agriculture, Department of A.H and Dairying and Fisheries (Animal Husbandry Statistics Division).

Agazzi,A.; Tirloni,E.; Stella,S.; Maroccolo,S.; Ripamonti,B.; Bersani,C.;Caputo, J.M. and Dellorto,V.(2014). Effects of species-specofoc probiotic addition to milk replacer on calf health and performance during the first month of life. *Annals of Animal Science*, 14 (1):101-115.

Ahmad Para, I., Singh, M., Punetha, M., Hussain Dar, A., Ahmad Naik, M., Salam Teli, A., & Gupta, D. (2018). Milk production and feed efficiencies as affected by dietary yeast (*Saccharomyces cerevisiae*) supplementation during the transition period in Murrah buffaloes. *Biological Rhythm Research*, *50*(5), 718–725.

Chaucheyras-Durand, F. and Fonty,G. (2006). Effects and modes of action of live yeast in the rumen. *Biologia.* 61:741-750.

Cai L, Yu J, Hartanto R, Qi D. Dietary Supplementation with *Saccharomyces cerevisiae*, *Clostridium butyricum* and Their Combination Ameliorate Rumen Fermentation and Growth Performance of Heat-Stressed Goats. *Animals*. 2021; 11(7):2116. https://doi.org/10.3390/ani11072116

Dharamsare, K. S.; Gampawar, A. S. and Gorantiwar, V. M. (1991). Effect of Supplementation of Subabul (*Leucaena teucocephala*) Seed on the Growth Rate of Heifers. *Indian Journal of Animal Nutrition*, 8(1): 61-64.

Gamal, A. R., Mohamed, F. F., & Elbana, R. A. (2019). Performance of beef buffalo calves in response to dietary supplementation of (Saccharomyces cerevisiae). *J. Egypt. Vet. Med. Assoc*, *79*, 1081-1087

Ghazanfar, S.; Anjum, M. I.; Azim, A. and Ahmed, I. (2015). Effects of dietary supplementation of yeast (*Saccharomyces cerevisiae*) culture on growth performance, blood parameters, nutrient digestibility and fecal flora of dairy heifers. *JAPS: Journal of Animal & Plant Sciences*, 25(1).

Klopp, R. N., Centeno-Martinez, R. E., Yoon, I., Johnson, T. A., & Boerman, J. P. (2022). Effects of feeding *Saccharomyces cerevisiae* fermentation products on the health and growth performance of Holstein dairy calves. *JDS communications*, *3*(3), 174-179.

Kumar, V. S., Chaudhary, S. S., Manat, T. D., Singh, R. R., Kuldeep, T., Nikhil, D., & Gaurav, P. (2018). Effect of Yeast (*Saccharomyces cerevisiae*) Supplementation on Haematological Parameters in Surti Buffalo Calves. *The Indian Journal of Veterinary Sciences & Biotechnology*, *14*(1), 34-37.

Lascano GJ; Zanton GI; Suarez-Mena Fx and Heinrichs AJ (2009). Effect of limit feeding high- and low-concentrate diets with *Saccharomyces cerevisiae* on digestibility and on dairy heifer growth and first-lactation performance. *J Dairy Sci.* Oct;92(10):5100-10.

Lukuyu, M. N.; Gibson, J. P.; Savage, D. B.; Duncan, A. J.; Mujibi, F. D. N. and Okeyo, A. M. (2016). Use of body linear measurements to estimate liveweight of crossbred dairy cattle in smallholder farms in Kenya. *SpringerPlus*, 5(1): 1-14.

Ma, J., Wang, C., Wang, Z., Cao, G., Hu, R., Wang, X. & Zhu, X. (2021). Active dry yeast supplementation improves the growth performance, rumen fermentation, and immune response of weaned beef calves. *Animal Nutrition*, *7*(4), 1352-1359

Maamouri, O., & Ben Salem, M. (2022). The effect of live yeast Saccharomyces cerevisiae as probiotic supply on growth performance, feed intake, ruminal pH and fermentation in fattening calves. *Veterinary medicine and science*, *8*(1), 398-404.

Moharrery, A. and Asadi, E. (2009). Effects of supplementing malate and yeast culture (*Saccharomyces cerevisiae*) on the rumen enzyme profile and growth performance of lambs. *J. Anim. Feed Sci*., 18(2): 283-295.

Panda, A.K.; Singh, R. and Pathak, N.N. (1995). Effect of dietary inclusion of *Saccharomyces cerevisiae* on growth performance of crossbred calves. *J. Appl. Anim. Res.*, 7 : 195-200.

Pandey, P. and Agarwal, I.S. (2001). Nutrient utilization and growth response in crossbred calves fed antibiotic and probiotic supplemented diets . *Indian Journal of Animal Nutrition* , 18(1) :15-18

Pinos-Rodriguez, J.;P.Robinson., M. Ortega.; S. Berry., G. Mendoza., and R.Barcena (2008). Performance and rumen fermentation of dairy calves supplemented with *S.cerevisiae* 1077 or *Saccharomyces bourdaii* 1079. *Anim. Feed Sci. Technol.* 140:223-232.

Ozkaya, S. and Bozkurt, Y. (2009). The accuracy of prediction of body weight from body measurements in beef cattle. *Archives Animal Breeding*, 52(4): 371-377.

Srivastava, A., Singh, C., & Kumar, H. C. A. (2017). Effect of probiotic supplementation on performance of crossbred kids under stallfed conditions.

Vahora, S.; Parnerkar, S. and Kore, K. (2012). Effect of feeding bypass nutrients to growing buffalo heifers under field conditions. *Livestock Research for Rural Development*, 24(2): 39.

Yasmin, F.; Alam, M. J.; Kabir, M. E.; Al Maruf, A.; Islam, M. A. and Hossain, M. M. (2021). Influence of Probiotics supplementation on Growth and Haemato-biochemical Parameters in Growing Cattle.