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Research Article

Effect of Genetic Crossing Between Native Bovine Cows with Holstein Friesian Bull on Body Water and Solids Content in Growing Calves Under Winter and Summer Seasons

Alsaied Alnaimy Habeeb* & Ahmed Elsayed Gad

Department of Biological Applications, Radioisotopes Applications Division, Nuclear Research Center, Atomic Energy Authority, Inshas, Cairo, Egypt

***Correspondence to:** Dr. Alsaied Alnaimy Habeeb, Department of Biological Applications, Radioisotopes Applications Division, Nuclear Research Center, Atomic Energy Authority, Inshas, Cairo, Egypt, dr_alnaimy@yahoo.com or alnaimy252011@gmail.com, orcid.org / (0000-0002-4758-9102).

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Abstract

Effect of genetic crossing on body water and body solids contents in growing calves under winter and summer seasons is the objective of this study. Twenty four calves after weaning including 12 native calves and 12 crossing 50% (F_1 from ♀ Egyptian cow x ♂ Holstein Friesian) were used in two experiments. The 1st experiment was conducted during winter season on twelve calves including 6 native calves and 6 F_1 calves with average 6-7 months of age and average live body weight of 150 kg. The 2nd experiment was conducted during summer season on another twelve calves with the same age and body weight including 6 native calves and 6 F_1 calves. Changes in each of live body weight (LBW), total body water (TBW), total body solids (TBS) and daily body weight gain (BWG) in native or F_1 calves under each of winter and summer seasons were estimated. Results showed that heat stress of summer season induced significant decrease in LBW through three months in native calves by 27.2 kg and in F_1 by 32.9 kg.

F_1 calves were better than native calves by 23.2 kg and 17.5 kg under winter and summer seasons, respectively. TBW as percentage of LBW values increased significantly due to exposure calves to summer season. TBS as absolute values through three months decreased significantly by 6.9 kg in native calves and by 9.0 kg in F_1 calves due to exposure calves to summer season. Daily live BWG and daily solids BWG in calves decreased significantly at the rate of 333.9 and 88.4 g, respectively. F_1 calves were better than native calves in live BWG by 20.4 kg in 90 days with daily of 226.1 g and in solids BWG by 8.2 kg /90 days the rate of 91.6 g daily. It can be concluded that the best values in each of BWG either expressed as a live or solids were in F_1 crossing calves under winter conditions and the worsted values were in native calves during summer season.

Introduction

Information on the body water content of the live animals, especially under heat stress conditions of summer season of Egypt, is important for research whether the research involves nutrition, physiology, genetic, disease and meat production. Body weight alone provides a poor index of the metabolically active tissue or the mass of tissue available for meat. Live body weight including total solids and total body water. Therefore, LBW of animals is a misleading index of growth performance, since it may be due to the increase in water retention and not to the increase in body protein and fat. In other words, a unit of LBW in one animal may be due to the increase in body water at the expense of body tissue loss, while in the other animal, may be due to the increase in body solids [1]. In addition, water retention is known to vary considerably between animals during growth due to difference in the rate of accumulation of the less hydrated, fat, collegen and fibrous in replacement of the more hydrated functioning protoplasmic mass and to the age difference in response to nutritional and climatic factors [2].

Using Antipyrine dilution technique as indirect methods of estimating body water, body solids (body weight - body water), body composition and detection the heat adaptability coefficient in live animals can provide repeated estimates for the same animal besides easily, accurate and quickly technique and more reliable whereas slaughter and chemical analysis obviously can only be done once [3].

The use of exotic bull breeds for crossbreeding purposes to take advantage of potential heterotic effects [4,5]. High productive imported animals like Brown Swiss or Holstein Friesian can be crossed with native cattle because such practice may allows the Egyptian native cattle producer to take advantage of appropriate combinations of the superior traits of Brown Swiss or Holstein Friesian breeds to yields heterosis which often referred to as hybrid vigor [6].

Farm animals reared under hot summer season in Egypt for almost 8 months of the year. Summer is characterized by high ambient temperature, intense solar radiation and high relative humidity. Therefore farm animals exposed to severe heat stress and become uncomfortable and the productive traits of animals are deleteriously affected by the disturbance in the normal water balance [2].

Little information was available on body water and body solids in each of native cattle calves and F_1 calves (produced from crossing between ♂ Holstein Friesian and ♀ Native cattle). Effect of genetic crossing on body water and body solids contents in growing calves under winter and summer seasons is the objective of this study.

Materials and Methods

The experimental wok was carried out in bovine farm project, Experimental Farms Project, Biological Application Department, Radioisotopes Applications Division, Nuclear Research Centre, Atomic Energy Authority, Inshas, Cairo, Egypt (latitude 31° 12'N to 22° 2'N, longitude 25° 53'E to 35° 53'E) during the year of 2017.

This work was reviewed and approved by the Animal Care and Welfare Committee of Zagazig University, Egypt (ANWD-206). These ethics contain relevant information on the Endeavour to reduce animal suffering and adherence to best practices in veterinary care according to the International Council for Laboratory Animal Science (ICLAS) guidelines. Experimental animals were also cared using husbandry guidelines derived from Egyptian Atomic Energy Authority standard operating procedures.

1. Animals And Feeding

The study was carried out on twenty four calves after weaning with average 6-7 months of age and average live body weight of 150 kg including 12 native calves and 12 crossing 50% (F_1 from ♀ Egyptian cows x ♂ Holstein Friesian) were used. Animals were fed the ration consisted of concentrate feed mixture (CFM) and rice straw (RS). The ingredients of the CFM and chemical composition of the feed stuffs used in the feeding of the calves are shown in Table (1).

2. Experimental Design

Twenty four healthy calves after weaning including 12 native calves and 12 crossing (F_1 from ♀ Egyptian cow x ♂ Holstein Friesian) were used in two experiments. The 1st experiment was conducted during winter season on twelve calves including 6 native calves and 6 F_1 calves with average 6-7 months of age and average live body weight of 150 kg.

The 1st experiment lasted 90 days from the 1st of January to the end of March, 2017, since the ambient temperature (AT) and relative humidity (RH %) values were 20.0±0.76°C and 69.9±0.30% respectively. The 2nd experiment was conducted during summer season on another twelve calves with the same age and body weight including 6 native calves and 6 F_1 calves. The 2nd experiment lasted 90 days from the 1st of June to the end of August, 2017, since the ambient temperature (AT) and RH% were 37.4±0.32°C and 50.2±0.73%, respectively (Table 2).

Table 1: *Ingredients of the concentrate feed mixture and chemical composition of the feed stuffs used in the feeding of the calves during the experimental period.*

Items	Concentrate feed mixture	Rice straw
Ingredients of the concentrate (%):		
Crushed yellow maize %	40.00	
Wheat bran %	25.50	
Soybean meal %	7.00	
Undecorticated cotton seed meal	25.00	
Dicalcium phosphate %	1.00	
Sodium chloride %	1.00	
Mineral mixture %*	0.50	
Vitamin AD_3E %	0.50	
Analysis of chemical composition of the feed stuffs (on DM basis), %:**		
Dry matter	89.81	92.30
Organic matter	94.00	83.52
Crude protein	15.68	3.20
Crude fiber	8.50	32.70
Ether extract	2.67	1.80
Nitrogen-free extract	67.15	44.60
Ash	6.00	17.70
Calculated Nutritive values of the feed stuffs :		
Net energy (MJ/kg DM)	4.00	1.60
Total digestible nutrients (%)	60.82	30.00
Digestible crude protein (g/kg DM)	115.0	0.00
Starch equivalent	0.50	0.20

*Vitamin and Mineral premix each 2.5 kg consists of: Vit A 12000, 000 IU; Vit D_3, 2000, 000 IU; Vit. E. 10g; Vit k_3 2 g; Vit B_1, 1000 mg ; Vit B_2, 49g ; Vit B_6, 105 g; Vit B_{12}, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g , Folic acid , 1000 mg ; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn , 45 g.
**According to AOAC (1990) [7].

Table 2: *Monthly averages of ambient temperature (AT,°C), relative humidity (RH%) and temperature humidity index (THI) values at midday during the two experiments during the year of 2016.*

Two experiments	Experimental months	Ambient temperature (AT,°C)	Relative humidity (RH%)	*Temperature humidity index (THI)*
1st experiment (Winter)	January	19.5±0.29	69.5±1.5	65.57
	February	19.0±0.41	69.8±2.1	64.84
	March	21.5±0.29	70.5±2.2	68.64
	Overall	**20.0±0.76**	**69.9±0.30**	**66.35**
2nd experiment (Summer)	June	36.8±1.4	51.5±0.44	87.51
	July	37.5±1.8	50.0±0.58	88.09
	August	37.9±1.5	49.0±0.48	88.36
	Overall	**37.4±0.32**	**50.2±0.73**	**87.99**

Each value from air temperature and relative humidity was the average of 4 numbers recorded weekly at 13.00 h.

*The THI was calculated as following THI= (1.8*AT + 32) – [(0.55 – 0.0055*RH) × (1.8*AT – 26)], where AT = air temperature (°C), and RH = relative humidity (%) according to Kendall and Webster (2009) [8] who reported that THI thresholds for heat stress in cattle as following: comfort (THI < 68), mild discomfort (68 < THI < 72), discomfort (72 < THI < 75), alert (75 < THI < 79), danger (79 < THI < 84), and emergency (THI > 84). THI values indicate that absence of heat stress (comfort) during winter and very severe heat stress (emergency) during summer seasons of Egypt.

3. Estimation of Gain

The animals were weighed monthly to the nearest 1 kg before the morning feed. Each calf was weighted monthly during each of winter and summer seasons to obtain live body weight (LBW). Daily body weight gain values were estimated by dividing total live body weight gain (kg) during each season (final LBW-initial LBW) by 90 days.

4. Animal Housing and Management

The experimental calves were left loose day and night during both winter and summer seasons in one separate soil-floored yard (20 x 40 meters) surrounded with wire fence (1.5 meter height).

One-third of the surface area of the yard was covered with concrete shading roof in the middle (3.5 meter height) with natural ventilation. The yard was provided also with troughs and source of tab fresh drinking water to be available automatically at all time to the animals.

5. Estimation of Total Body Water (TBW) Using Antipyrine (ANP)

Each animal was injected in the left jugular vein with antypyrine (ANP) at the rate of 1g per 100 kg live weight in both the beginning and the end of winter and summer seasons to determined total body water (TBW) according to Habeeb (2010) [9]. After 1 hour from injection of ANP to be distributed in all animal body, blood samples were withdrawn from write jugular vein for TBW and consequently total body solids (TBS) by subtracting TBW from live body weight. Solids body weight gain was estimated by dividing TBS (kg) by 90 days. Chemical reagents required for ANP estimation are zinc reagent solution (10%), sodium hydroxide (0.75N), sodium nitrite (0.2%) and H_2SO_4 acid with different normality (6N, 4N and 0.07N). Precipitation of plasma proteins in plasma samples was carried out using zinc sulphate and centrifuged at the rate of 2000 rpm for 20 minutes. ANP concentration in supernatant was estimated by computerized spectrophotometer at 350 UV. TBW, ml in animals was determined by dividing concentration of ANP injected (μ) / concentration of ANP in plasma sample (μ/ml).

To determine percentage of heterosis, divide the amount of heterosis by the native average; then multiply by 100%; this yields a heterosis value for the F_1 calves [5].

6. Statistical Analysis

Data were statistically analyzed by two-ways analysis of variance using the General Liner Model Procedure of the SAS software [10]. The model used is: $Y_{ij} = \mu + S_i + T_j + (ST)_{ij} + e_{ijk}$ where: μ = the overall mean; S_i = the fixed effect of season (1 = winter and 2 = summer); T_j = the fixed effect of type of calves (1 = native and 2 = F_1); $(ST)_{ij}$= the interaction between the season and type of calves and e_{ijk} = random error. Significance of the difference in the results was verified by Duncan's new multiple ranges test [11]. The percentage change due to summer heat stress (HS) as compared to mild climate of winter season (MC) was calculated as (MC-HS) x100/MC. The percentage change due to crossing (C) in F_1 as compared to native (N) was calculated as (C- N) x100 / N.

Results

1. Effect of Heat Stress Conditions of Summer Season on LBW, TBW% and TBS

LBW of native calves increased by 52.7 during winter and 25.5 kg during summer seasons, indicating that heat stress conditions induced significant decrease in LBW of native calves in 90 days by 27.2 kg (51.4%). In F_1 calves, LBW through 3 months increased 75.9 during winter and 43.0 kg during summer seasons. This result means that summer season induced significant decrease in LBW of F_1 calves in 90 days by 32.9 kg (43.3%). When comparing between the two breeds, the result of LBW showed that F_1 calves were better than native calves by 23.2 kg (75.9 vs.52.7) and 17.5 kg (43.0 vs. 25.5) under both winter and summer seasons, respectively (Table 3).

***Table 3:** Changes in live body weight (LBW), total body water (TBW) and total body solids (TBS) in both native and F_1 calves due to exposed to winter or summer season in Egypt.*

Changes in Parameters	Type of calves	winter season	Summer season	Change due to heat stress of summer season	p values
Change in LBW, kg	Native calves	+52.7	+25.5	-27.2 kg (51.4%)	P<0.01
	F_1 calves	+75.9	+43.0	-32.9 kg (43.3%)	P<0.01
Change in TBW as percentage of LBW	Native calves	65.1	68.1	+3.0	P<0.01
	F_1 calves	66.1	70.0	+3.9	P<0.01
Change in TBS, kg as absolute value	Native calves	+19.4	+12.5	-6.9 kg (35.6%)	P<0.01
	F_1 calves	+28.7	+19.7	-9.0 kg (31.4%)	P<0.01
Change in TBS, kg as percentage of LBW	Native calves	34.9	31.9	-3.0	P<0.01
	F_1 calves	33.9	30.0	-3.9	P<0.01

The percentage change due to summer heat stress (HS) as compared to mild climate of winter season (MC) was calculated as (MC- HS) x100/MC.

TBW as percentage of LBW values increased significantly due to exposure either native or F_1 calves due to summer heat stress conditions. TBW% value in native was 65.1 under winter climate and increased to 68.1 under summer season. In F_1 calves TBW% value was 66.1 under winter climate and increased to 70.0 under summer season (Table 3).

In native calves, total body solids (TBS) as absolute value in kilograms increased significantly by 19.4 kg during 90 days of winter season and 12.5 kg during 90 days of summer season, indicating that heat stress conditions of summer season induced significant decrease in TBS by 6.9 kg. In F_1 calves, TBS as absolute value as kg increased significantly during 90 days by 28.7 and 19.7 kg in winter and in summer seasons, respectively. This result means that heat stress conditions of summer season induced significant decrease in TBS of F_1 calves by 9.0 kg.

TBS as percentage of LBW values decreased significantly due to exposure either native or F_1 calves to summer heat stress conditions. TBS% value in native was 34.9% under winter climate and decreased to 31.9% under summer season. In F_1 calves TBS% value was 33.9% under winter climate and decreased to 30.0% under summer season.

When comparing between the two breeds, the result showed that F_1 calves were better than native calves by 9.3 kg (28.7 vs.19.4) and 7.2 kg (19.7 vs. 12.5) under both winter and summer seasons, respectively (Table 3).

2. Effect of Heat Stress Conditions of Summer Season on Live and Solids Gain

Heat stress conditions of summer season induced highly significant reduction in live total body weight gain of calves by 30.0 kg through 3 months at the rate of 333.9 g daily when compared to mild climate conditions of winter season. The percentage decrease due to heat stress reached to more than 45% without consideration of calve type (Table 4).

Table 4: *Changes in total and daily live and solids gain in native and F_1 calves due to exposed to winter or summer season in Egypt.*

Factors affect	Total live gain (kg/3 months)	Daily live body gain (g/ day)	Total solids gain (kg/3 months)	Daily solids gain (g/ day)
Seasons				
Winter	64.3±1.5	714.5±18.1	24.1±0.7	267.3±7.8
Summer	34.3±1.7	380.6±18.6	16.1±0.8	178.9±7.5
Decrease due to hot summer	30.0 (-46.7%)	333.9 (-44.7%)	8.0 (-33.2%)	88.4 (-33.1%)
Significance (p≤)	0.001	0.001	0.001	0.001
Type of calves				
Native calves	39.1±1.8	434.5±15.1	16.0±0.6	177.3±8.8
F_1	59.5±1.5	660.6±15.6	24.2±0.7	268.9±9.8
Increase in F_1 vs. native	20.4 (+52.2%)	226.1 (+52.0%)	8.2 (+51.3%)	91.6 (+51.7%)
Significance (p≤)	0.001	0.001	0.001	0.001
Interactions between season and type of calves				
Winter				
Native calves	52.7 ±3.2 ^{b}	585.6±32.9 ^{b}	19.4±0.9 ^{b}	215.6±10.3^{b}
F_1	75.9 ± 0.64 ^{a}	843.3±7.1 ^{a}	28.7±0.8 ^{a}	318.9±8.8^{a}
Increase in F1 vs. native	23.2 (+44.0%)	257.7 (+44.0%)	9.3 (+47.9%)	103.3 (+47.9%)
Summer				
Native calves	25.5± 0.8 ^{d}	283.3± 9.3 ^{d}	12.5±0.3 ^{c}	138.9±3.7 ^{c}
F_1	43.0± 3.5 ^{c}	477.8± 38.7 ^{c}	19.7±1.5 ^{b}	218.9±16.9 ^{b}
Increase in F1 vs. native	17.5 (+68.6%)	194.5 (+68.7%)	7.2 (+57.6%)	80.0 (+57.6%)
Significance (p≤)	0.05	0.05	0.05	0.05

The percentage change due to summer heat stress (HS) as compared to mild climate of winter season (MC) was calculated as (MC- HS) x 100 / MC. The percentage change due to type of calves, F_1 (C) as compared to native (N) was calculated as (C- N) x100 / N.
a, b, c…..Different letters in each column of interaction indicate significant differences (a > b > c > d)

When expressed total gain as solids, the results showed that the stressful condition of hot summer conditions induced significant reduction in total solids gain in claves by 8.0 kg in 90 days at the rate of 88.4 g daily when compared to absence of heat stress during winter season and the percentage decrease due to heat stress reached to more than 33% without consideration of calve type (Table 4).

When comparing between the two breeds, the result showed that F_1 calves were better than native calves in live total gain by 20.4 kg with daily of 226.1 g with superiority of 52%. The same trend, F_1 calves were better than native calves in total solids gain by 8.2 kg at the rate of 91.6 g daily with best more than 50%.

Data concerning the interaction between seasons and type of calves shows that the best values in each of total and daily BWG either expressed as a live or a solids were in F_1 calves under winter conditions (843.3 g and 318.9 g for live and solids, respectively) and the worsted values were in native calves during summer season (283.3 g and 138.9 g for live and solids, respectively) as shown in Tables (4, 5 and 6).

Table 5: *Analysis of variance of live total and daily gain as affected by season, type of calves and their interactions.*

Source of variance	df	Live gain			
		Total		Daily	
		MS	f-value	MS	f-value
Season (S)	1	9003	162***	1167247	178.55***
Type of calves (T)	1	4168	75***	477204	73.00***
S x B interaction	1	182	3.3*	16406*	2.51*
Error	44	55.6		6537	
Total	47				

***P<0.001, *P<0.05

Table 6: *Analysis of variance of solids gain (total and daily) as affected by season, type of calves and their interactions.*

Source of variance	df	Solids gain			
		Total		Daily	
		MS	f-value	MS	f-value
Season (S)	1	619	63.8***	75065	62.46***
Type of calves (B)	1	703	72.4***	85120	70.83***
S x B interaction	1	28	2.9*	3032	2.51*
Error	44	9.7		1202	
Total	47				

***P<0.001, *P<0.05

Discussion

1. Effect of Heat Stress Conditions of Summer Season on LBW

Summer season conditions induced significant decrease in LBW by 27.2 kg (51.4%) in native calves and by 32.9 kg (43.3%) in F_1 calves and F_1 calves were better than native calves by 23.2 kg and 17.5 kg under both winter and summer seasons, respectively (Table 3).

Growth traits of calves are deleteriously affected by heat stress conditions of summer season and calves LBW improved significantly in F_1 (½ Brown Swiss x ½ Native cows) calves due to crossing process under both winter and summer seasons [3,12]. Holstein crossed with local breeds in the tropics and subtropics perform better than the purebred Holstein and were also resistant to heat stress [13,14]. The depression in LBW in calves under summer season is due to that animals suffer extremely by severe stress conditions which associated in disturbance in the normal physiological balance and biological functions [15]. In addition, high environmental temperature during hot summer season stimulates the peripheral thermal receptors to transmit suppressive nerve impulses to the appetite centre in the hypothalamus causing the decrease in dry matter intake (DMI). Thus, fewer substrates become available for enzymatic activities, hormone synthesis and heat production and consequently LBW of calves are decreased [2]. The feed intake of cows at 40˚C is reduced by 20-40% compared with cows in thermoneutral environment. In addition, during heat stress, DMI, gut motility, rumination, ruminal contractions are reduced due to depress animal appetite by having a direct negative effect on appetite centre of the hypothalamus [16]. Increase in environmental temperature has a direct negative effect on appetite center of the hypothalamus to decreases feed intake. Feed intake begins to decline at air temperatures of 25-26˚C in lactating cows and reduces more rapidly above 30˚C in temperate climatic condition and at 40˚C it may decline by as much as 40% [17] or 8-10% in buffalo heifers [18]. Reducing feed intake is a way to decrease heat production in warm environments as the heat increment of feeding is an important source of heat production in ruminants [19]. As results, animals experience a stage of negative energy balance (NEB), consequently body weight and body condition score goes down [20].

2. Effect of Heat Stress Conditions of Summer Season on TBW

TBW as percentage of LBW values increased significantly either in native or in F_1 calves due to exposure to summer heat stress conditions (Table 3). The water requirements are determined by the amount needed to give the proper osmotic concentration to body fluids and to compensate for total water loss. To maintain TBW content at a relatively constant level it is important that a continuous supply of water must be provided. In a steady state (comfortable conditions), water intake (including free water, feed water and metabolic water, which is derived from oxidation of fat, carbohydrates and proteins) must balance water output (including urine, sweating, skin vaporization and respiratory vaporization) as declared previously by [2]. Under hot climate, water plays a major role in heat dissipation through evaporative cooling including sweating (skin vaporization), and respiratory vaporization and thermal conduction between consumed water and both of body core and excreted water through urine, feces, milk, salivation, tears and nasal tract secretions but vaporization at high temperature is considered the main route of heat dissipation [21].

The increase in TBW in calves during summer season is due to that the increase in water vaporization which stimulates the peripheral thermal receptors to transmit suppressive nerve impulses to the thirst centre in the hypothalamus causing the increase in water consumption [12].

Thermal stress increases water metabolism and maximum water intake during the hot period was at least doubled from the control period, from 4.8 to 9.8% in Bos taurus and 3.8 to 9.3% in Bos indicus. This is mainly due to lower plasma concentrations of metabolic hormones such as thyroxin, growth hormone and corticoids [22,16].

3. Effect of Heat Stress Conditions of Summer Season on TBS

Heat stress conditions of summer season induced significant decrease in TBS as absolute value in kilograms through 3 months by 6.9 kg in native calves and by 9.0 kg in F_1 calves (Table 3). In growing buffaloes, TBS were similarly lower at 32˚C and 50% RH than at 18˚C and 50% RH (100 and 124 kg, respectively) [23]. In Holstein calves, the heat caused a 15% decrease significantly in TBS [24]. In buffaloes and Friesians, the TBS decreased by 11.42% at each level of temperature, when the ambient temperature increased from 16˚C, 50% RH to 32˚C, 50% RH, constantly for one week, in the climatic chamber [25]. In Friesian calves, the average body solid content decreased by 16% with the increase in ambient temperature in the climatic chamber and concluded that the destruction of body tissues as a result of heat exposure is considered to be a serious stage of heat stress in animals Kamal (1982) [26]. Heat stress induced significant decrease in TBS in both male and female Friesian calves [27].

4. Effect of Heat Stress Conditions of Summer Season on Total Live and Total Solids Gain

Total live and total solids gain values are decreased by 30.0 and 8.0 kg through 3 months at the rate of 333.9 and 88.4 g daily due to exposure the experimental calves to hot summer season. F_1 calves were better than native calves in live BWG by 20.4 kg through three months with daily of 226.1 g and in solids BWG by 8.2 kg through three months at the rate of 91.6 g daily (Table 4).

Heat stress conditions of 36.0 and 32.0˚C induced significant reduction in DBWG of buffalo calves by 22.6 and 16.5%, respectively, when compared to mild climate conditions (18.0˚C) [28]. Stressful condition of hot climatic conditions induced significant reduction in DBWG of bovine claves and the percentage heat induced change were ranged between 3.2 to 48.4% with average of 25.5% [29]. The heat stress induced a highly significant decline in DBWG in Friesian calves by 14.0, 29.0 and 22.0% during May, June and July months, respectively [30]. The heat stress conditions of summer season induced significant decline in DBWG of buffalo calves by 18.1, 17.41 and 8.65% during 1st, 2nd and 3rd months of summer season, respectively [31]. Calves body weight gains (either live or solids) improved significantly in F_1 (½ Brown Swiss x ½ Native cows) calves due to crossing process under both winter and summer seasons [12].

The decrease in calves body weight gains (either live or solids) during summer season may be due to a decrease in feed consumption, dehydration of animals, tissue catabolism and to the low metabolically energy left for growth, since more energy is consumed by the increase in respiratory frequency that occurs in hot ambient temperature [6,15].

DMI was significantly lower during summer than those during winter [32]. Dry matter intake (DMI) was significantly lower during summer than those during winter and the percentage decrease was 22.5 in native bovine calves and was 24.8 in F_1 (½ brown Swiss x ½ Native cows) calves [12]. Feed conversion values as kg DMI/kg gain were 7.35±0.32 and 10.97±0.22 in bovine calves and were 5.03±0.12 and 6.67±0.25 in F_1 (½ brown Swiss x ½ Native cows) calves under winter and hot summer seasons, respectively. FC was significantly higher during summer than those during winter by 3.62 kg DMI/kg gain in native bovine calves and by 1.64 kg DMI/kg gain in calves. The percentage increase due to hot summer season was 49.25 in native bovine calves and was 32.6 in F_1 calves compared to winter season [12]. In this measure, a higher number of FC indicates less efficiency.

Animal decrease DMI in an attempted to create less metabolic heat, as the heat increment of feeding, especially in ruminants is a large portion of whole body heat production [19]. Decrease in DMI cause the decrease in the substrates and hormones which inhibit the enzymatic activities and decrease the metabolism and consequently impair DBWG. In addition, exposure animals to hot summer environment can affect digestibility of feed stuffs [33]. The decrease in thyroid hormonal levels and the increase in cortisol hormone during summer season may also contribute in TBS losses and in depression of gain either live or solids during summer season [12].

The superiority of F_1 in body weight gains (either live or solids) than native calves may be due to superiority in feed intake during summer season. DMI and feed conversion values were improved significantly in F_1(½ Brown Swiss x ½ Native cows) calves due to crossing process under each of winter and summer season [12]. DMI was higher in all the crosses than in purebred Brahman animals and consequently fed conversion improved due to crossing [34].

Conclusion

Heat stress conditions of summer season had adversely affects on growth traits of both native and F_1 calves. F_1 calves were better than native calves in live and solids BWG more than 50%. Moreover, the best body gain was in crossing calves under both winter and summer seasons.

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