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Improving Live and Dry Body Weight Gain of Bovine Native Calves during Hot Summer Season of Egypt using Genetic Crossing Process

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ABSTRACT

The objective of this research is study the importance of crossing in improving body weight gain of native cattle calves during hot summer season of Egypt. Twenty healthy calves including 10 native cattle calves and 10 F1 (produced from mating Brown Swiss♂ with Native cattle ♀) were used in the experiment. The experimental calves of two groups were the same each of age and live body weight. Experimental calves of the two groups were exposed to mild climate of winter season for 3 months followed by exposure the same calves to hot climate of summer season for 3 months. Results showed that calves body weight gains (either live or solids) improved significantly in F1 (½ Brown Swiss x ½ Native) calves due to crossing process under both winter and summer seasons. Thyroid hormones (T3 and T4) values in both two groups were found to be highly significantly lower in summer than in winter. While cortisol level in calves of the two groups was significantly higher during summer than those in winter. Dry matter intake (DMI) in two experimental groups was significantly lower during summer than those during winter. Feed conversion (FC %) was significantly higher during summer than those during winter. DMI and FC% values were improved significantly in F1 calves due to crossing process under each of winter and summer season.

It can be concluded that growth and feed performance in crossing calves are better than native cattle calves under each of winter and summer season.

Keywords: *Calves, gain, crossing, hormones, hot summer, hormonal levels;*

INTRODUCTION

The summer in Egypt is characterized by high ambient temperature, intense solar radiation and high relative humidity. Therefore, farm animals raised in such sever climatic stress for almost 8 months of the year and become uncomfortable and they suffer extremely in production, reproduction and resistance to diseases and parasites. Growth traits of Egyptian native animals under hot summer season are deleteriously affected by the disturbance in the normal physiological balance and biological functions (Marai and Habeeb, 2010b).

The Egyptian native cattle (Baladi) are characterized by low milk production inputs used in suckling their borne calves (Mostageer et al., 1990) and also low daily body weight gain (300-500g/d) according to birthing season (Habeeb et al., 2014). Therefore, due to low yielding, most of the milk producers are interested in importing dairy cattle from Europe or USA either for expansion existing or for new dairy farms. For improving the Egyptian native cattle (Baladi), some researchers in Egypt tried grading up Baladi cattle (low yielding) with Friesian bulls as high yielding breed (Mostageer et al., 1987). Our project aims to study crosses between Egyptian native cattle cows with imported purebred (Brown Swiss) bull to produce F1 highest in daily live body gain and in the same time adapted to severe heat stress of hot summer of Egypt as a first objective. The second objective is studying the physiological, biochemical and biological changes in first generation of crossing, especially, during adaptation of first generation to hot conditions during summer season of Egypt. These aims of crossing are to transmit the superior phenotypic characteristics of high yielding breed to the first generation offspring (Habeeb et al., 2014). The use of exotic bull breeds for crossbreeding purposes to take advantage of potential heterotic effects (Olson 2011). High productive imported animals like Brown Swiss or Holstein Friesian can be crossed with native cattle because such practice may raise the productivity of the heat tolerant of native cattle and 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 (Marai and Habeeb, 2010a).

Little information was available on performance of such introduced breeds and their crossing with native bovine cattle, especially, under the climatic conditions of Egypt. The objective of this research is evaluate the growth and feed performance as well as hormonal levels in each of native cattle calves and F1 calves (produced from crossing between ♂Brown Swiss and ♀ Native cattle) under winter season as mild climate and under summer season as hot climate.

MATERIALS AND METHODS

The present study was conducted in bovine farm project, Experimental Farms Project, Biological Application Department, Radioisotopes Applications Division, Nuclear Research Centre, Atomic Energy Authority, Inshas, Cairo, Egypt. A number of 20 calves after weaning with 5 months of age were used in this research. Animals were fed the ration consisted of concentrate feed mixture (CFM), clover hay (CH) and rice straw (RS) according to their requirements (NRC, 1981). Ingredient and analysis of chemical composition of the feed stuffs (on DM basis %) according to AOAC (1990) and calculated nutritive values are presented in Table (1).

Table1. *Ingredients of the concentrate feed mixture (CFM) and analysis of chemical composition of the feed stuffs used in calves feeding during the two periods of experiment.*

Ingredients and chemical Composition of feed stuffs	Feed stuffs		
	Concentrate feed mixture	**Clover hay**	**Rice straw**
Ingredients of the concentrate* (%):			
Un-decorticated cotton seed meal	35.00		
Yellow maize	30.00		
Wheat bra	30.00		
Soy bean meal	5.00		
Analysis of chemical composition of the feed stuffs (on dry matter basis):			
Dry matter	88.31	89.00	92.30
Organic matter	87.11	82.66	83.52
Crude protein	17.68	14.20	3.20
Crude fiber	15.50	25.10	32.40
Ether extract	2.87	2.60	1.30
Nitrogen-free extract	47.28	34.60	36.60
Ash	6.00	12.50	18.80
Calculated nutritive values of the feed stuffs:			
Net energy (MJ/kg DM)	4.00	2.64	1.60
Total digestible nutrients (%)	60.82	48.00	30.00
Digestible crude protein (g/kg DM)	115.0	80.00	------

**Each 100 kg concentrates was supplemented with 100 g minerals mixture (Each kg contains 40g Mn, 3 g Cu, 0.3g I, 0.1g Si and 30g Fe from Pfizer-Co., Egypt), 100 g vitamins mixture (AD3 E) , 2 kg Aliphos Dical 18 (Dicalcium phosphate) and 1 kg coarse refined iodized kitchen salt (El-Nasr Saline's Co. , Egypt).*

Experimental Design

Twenty healthy calves including 10 Egyptian native bovine calves (1st group) and 10 F1 ½ Brown Swiss x ½ Native calves (2nd group) were used in the experiment. F1is the 1st generation offspring calves produced from crossing between ♀female Egyptian cattle with ♂Brown Swiss bull. The experimental calves in both two groups were the same ages and body weight. Calves of two experimental groups were exposed to mild climate of winter season for 3 months from the 1st of January 2015 to the end of March 2015, since the average of ambient temperature (AT) and relative humidity were 22.0±0.87°C and 65.4±2.5%, followed by exposure the same calves to summer climate for 3 months from the 1st of June to the end of August 2015), since the average AT and RH% were 35.25±0.72°C and 55.6±1.03%, respectively (Table 2). Animals during April and May months were out of experiment.

Severity of heat stress was estimated by Temperature-humidity Index (THI) according to (Valtorta et al., 1996) as following: THI = $(1.8T_C+32) - (0.55-0.55RH/100)\ (1.8T_C-26)$ where T_C =Air temperature (ºC) and RH=Relative humidity (%). The THI values obtained were then classified as follow: <70 = Normal or absence of heat stress; 70 to 80 = Alert or moderate heat stress; 79 to 82= Danger or severe heat stress and >82= Emergency or very severe heat stress. Average of THI was 69.02 during winter and was 89.35 during summer indicating that the experimental calves were exposed to severe heat stress during summer season and absence of heat stress during winter season (Table 2).

The experimental calves were left loose day and night during both winter and summer seasons. Native bovine calves served in separate yard and F1 group was also served in another separate yard. Each yard (20 x 40 meters) surrounded with wire fence (1.5 meter height) and 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 two yards were provided with troughs and source of tab fresh drinking water to be available automatically to the animals at any time.

Table2. *Monthly averages of Ambient temperature (AT °C), relative humidity (RH %) and Temperature humidity index (THI) values at midday during winter and summer seasons.*

Seasons	Months	Ambient temperature (° C)	Relative humidity,%	Temperature humidity index (THI*)
Winter season	January	20.5 ± 0.29	67.2±2.20	66.94
	February	22.0 ± 0.41	62.7±2.20	68.74
	March	23.5 ± 0.29	66.3±1.80	71.20
	Overall	22.0 ± 0.87	65.4±2.50	69.02 (Absence of heat stress)
Summer season	June	34.0 ± 0.41	57.5±1.44	84.96
	July	35.25 ±0.25	54.0± 0.58	86.12
	August	36.5 ± 0.29	55.25±0.48	87.93
	Overall	35.25±0.72	55.6 ±1.03	89.35 (Very severe heat stress)

Measurements

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.

For estimation total body water, each animal was injected in the left jugular vein with 1g antypyrine (ANP) diluted in distiller water per 100 kg live weight at the beginning and end of each of winter and summer periods and blood samples withdrawn from right jugular vein after 1 hour from injection according to Habeeb **(2010).** Precipitation of plasma proteins in plasma samples using zinc sulphate and estimation of ANP concentration from the supernatant solution with 0.1 ml sodium nitrite and one drop H_2So_4. The optical density of ANP was read on invisible light (ultra violet) (350 nanometer) using digital spectrophotometer. Total body water (TBW) in animals was determined as following: TBW = ANP injected /ANP in plasma sample. Total body solids (TBS) or dry body weight = live body weight (kg) – total body water (kg). Then solids body weight gain was estimated by dividing TBS (kg) by 90 days. Food consumption (CFM, CH and RS) was measured monthly once by subtracting the residuals of feed from that offered in the previous day for the ten calves and calculated as DMI. Feed conversion was calculated as Kg DMI/Kg gain. Water consumption was measured monthly once by subtracting the residuals of water from that offered in the previous day for 10 calves.

Blood Sampling and Analysis

At the end each of winter and summer season, one blood sample was withdrawn from the Jugular vein of each calf before the morning feed in vacutainer tubes containing EDTA as anticoagulation. Blood samples tubes were placed immediately on ice-box and were transferred to the laboratory. Plasma was separated by centrifugation (2000x g for 30 min.) and stored at -20°C until the hormones determinations. Thyroid hormones (T_3, T_4) and cortisol hormone were estimated using Radioimmunoassay technique (RIA) by commercial kits purchased from diagnostic product corporation, Los Angeles, USA. The unknown samples or standards are incubated with ^{125}1-labeled hormone in antibody-coated tubes. After incubation, the liquid contents of the tube are aspirated and the radioactivity is determined in computerized gamma counter. All determinations were carried out in the tracer bioclimatology unit, Department of Biological Applications, Nuclear research center, Atomic Energy Authority, Cairo, Egypt.

Statistical Analysis

Data were statistically analyzed by analysis of variance (2 x 2 factorial designs) using the General Liner Model Procedure of the SAS software procedure (SAS, 1995). The model used as following:

$Y_{ijk} = \mu + G_i + S_j + GS_{ij} + e_{ijk}$ where μ = the overall mean, , G_j = the fixed effect of group (1= 1st group (Egyptian native bovine calves as purebred) and 2= 2nd group (F1 ½ Brown Swiss x ½ Native calves as crossbred, S_i = the fixed effect of season (1=winter and 2=summer), GS_{ij} = the interaction between group and season and e_{ijk}= random error. Significance of the difference between the means was verified by Duncan's new multiple ranges test (Duncan, 1955). Superiority of crossbreds was measured by the difference between average performance of crossbred animals and average performance of the breeds that were crossed to produce them. The amount of heterosis produced by the cross is calculated by subtracting the average of the weights for purebred calves from the average of the weights for crossbred calves. The amount of heterosis produced by this cross is expressed in terms of the percentage of improvement that crossbreds exhibit above the purebred average**.** It calculated using the average traits values as follows [(C-P) / P] x 100 where: C= the average of crossbred and P = the value of the purebred calves. The percentage change due to summer heat stress (HS) as compared to mild climate of winter season (MC) was calculated as [(MC-HS) / MC] x 100. The values presented in all Tables are average ± standard error.

RESULTS

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Growth Traits

Averages of total live gain values in 90 days were lower during summer season than during winter season by 23.52 kg (48.0%) in native bovine calves and by 32.87 kg (43.3%) in F1 (½ brown Swiss x ½ Native cows) calves. Accordingly, daily live body weight gain values were found to be highly significantly lower in summer than in winter in native bovine calves by 261.3 g and 365.0 g in F1 (½ brown Swiss x ½ Native cows) calves (Table 3).

Table3. *Effect of heat stress conditions of hot summer season and crossing on growth traits.*

Growth performance	Winter season: Native cattle calves	Winter season: F1 (½ brown Swiss x ½ Native cattle) calves	Summer season: Native cattle calves	Summer season: F1 (½ brown Swiss x ½ Native cattle) calves
Total live gain (90days), kg	48.97^b±4.1	75.87^a±0.64	25.45^c±0.84	43.00^b±3.49
Effect of heat stress of summer			23.52 kg-	32.87 kg-
Change % due to HS			(-48.0%)***	(-43.3%)***
Improving due to crossing	+26.9 kg		17.6 kg+	
Change % due to crossing	(+54.9%)***		(+69.2%)***	
Total solids gain (90days), kg	19.49^b±0.92	28.71^a±0.79	12.51^c±0.34	20.00^b±1.52
Effect of heat stress of summer			-6.98 kg	-8.71 kg
Change % due to HS			(-35.8%)***	(-30.3%%)***
Improving due to crossing	+9.22 kg		7.49 kg+	
Change % due to crossing	(+47.3%)***		(+59.9)***	
Daily live body gain, g	544.0^b±32.3	843.0^a±7.13	282.7^d ±9.3	478.0^c± 38.7
Effect of heat stress of summer			-261.3 g/day	-365.0 g/day
Change % due to HS			(-48.0%)***	(-43.3%)***
Improving due to crossing	+299.0 g/day		+195.3 g/day	
Change % due to crossing	(+55.0%)***		(+69.0%)***	
Daily solids gain, g	216.6^b±10.3	319.0^a±8.86	139.2^c ± 3.7	222.0^b ± 16.9
Effect of heat stress of summer			-77.4 g/day	-97.0 g/day
Change % due to HS			(-35.7%)***	(-30.4%)***
Improving due to crossing	+102.4 g/day		+82.8 g/day	
Change % due to crossing	(+47.3%)***		(+59.5%)***	

****Different letters indicate significant differences (a > b > c > d, P<0.001)*

Values are expressed as mean ± SE

Total solids gain due to heat stress conditions of hot summer season decreased significantly from 19.49 kg to 12.51 kg (6.98 kg; 35.8%) in native bovine calves and from 28.71 kg to 20.00 kg (8.71 kg; 30.3%) in F1 (½ brown Swiss x ½ Native cows) calves. Accordingly, daily solids gain values were found to be highly significantly lower in summer than in winter in native bovine calves by 77.4 g (35.7%) and 97.0 g (30.4%) in F1 (½ brown Swiss x ½ Native cows) calves (Table 3).

Crossing between ♂brown Swiss with♀ native cows improved significantly total live gain and total solids gain values in 90 days by 26.9 kg (54.9%) and 9.22 kg (47.3%) in winter and 17.6 (69.2%) and 7.49 kg (59.9%) in summer, respectively. Accordingly, daily live body gain and daily solids gain values were found to be highly significantly lower in native bovine calves than in F1(½ brown Swiss x ½ Native cows) calves by 299.0 g (55.0%) and 102.4 g (47.3%) during winter season and by 195.3 g (69.0%) and 82.8 g (59.5%) during summer season, respectively (Table 3).

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Water intake, Dry Matter intake and Feed Conversion

Water intake (WI)

Water intake (WI) values in Egyptian native bovine calves and F1 (½ brown Swiss x ½ Native cows) calves were significantly higher during summer than those during winter with percentage increase 63.9 in native bovine calves and 66.5 in F1 (½ brown Swiss x ½ Native cows) calves. No significant difference in WI between the two experimental groups (Table 4).

Table4. *Effect of heat stress conditions of hot summer season and crossing on dry matter intake (DMI), water intake (WI) and feed conversion (FC%).*

Dry matter intake, water intake and feed conversion	Winter season		Summer season	
	Native cattle calves	F1 (½ brown Swiss x ½ Native cattle) calves	Native cattle calves	F1 (½ brown Swiss x ½ Native cattle) calves
Water intake (l/day)	$24.44^{b}\pm0.70$	$25.39^{b}\pm0.40$	$40.06^{a}\pm0.98$	$42.28^{a}\pm0.95$
Effect of heat stress (HS) of summer			+15.62 L/day	+16.89 L/day
Change percentage due to HS			(63.9%)***	(66.5%)***
Change due to crossing	(+0.95 L/day)NS		(+2.22 L/day)NS	
DMI (kg/day)	$4.00^{a}\pm0.09$	$4.24^{a}\pm0.07$	$3.10^{b}\pm0.05$	$3.19^{b}\pm0.07$
Effect of heat stress of summer			-0.90 kg/day	-1.05 kg/day
Change percentage due to HS			(-22.5%)**	(-24.8%)**
Change due to crossing	(+0.24 kg/day)NS		(+0.09 kg/day)NS	
Feed conversion (Kg DMI/Kg gain)	$7.35^{b}\pm0.32$	$5.03^{d}\pm0.12$	$10.97^{a}\pm0.22$	$6.67^{c}\pm0.25$
Effect of heat stress of summer			+3.62 Kg DMI/kg gain	+1.64 Kg DMI/kg gain
Change percentage due to HS			(+49.25%)***	(+32.60%)***
Change due to crossing	-2.32 kg DMI/kg gain		-4.30 kg DMI/kg gain	
Change percentage due to crossing	(-31.56%)**		(-39.20%)**	

*Different letters indicate significant differences (a > b > c > d), NS=Not significant, **= Significant at P<0.01 and ***= Significant at P<0.001. Values are expressed as mean ± SE.*

Dry matter intake (DMI)

Dry matter intake (DMI) was significantly lower during summer than those during winter in both two experimental groups. The percentage decrease was 22.5 in native bovine calves and was 24.8 in F1 (½ brown Swiss x ½ Native cows) calves. No significant difference in DMI between the two experimental groups (Table 4).

Feed conversion (FC)

Feed conversion (FC) values as kg DMI/kg gain were 7.35±0.32 and 10.97±0.22 in native bovine calves and were 5.03±0.12 and 6.67±0.25 in F1 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 F1 (½ brown Swiss x ½ Native cows) calves. The percentage increase due to hot summer season was 49.25 in native bovine calves and was 32.6 in F1 (½ brown Swiss x ½ Native cows) calves compared to winter season (Table 4). In this measure, a higher number of FC indicates less efficiency.

Crossing between ♂brown Swiss with♀ native cows improved significantly feed conversion by

2.32 Kg DMI/Kg gain (31.56%) under winter season and increased to 4.3 Kg DMI/Kg gain (39.2%) under summer season.

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Thyroid and Adrenal Hormonal Levels

Thyroxin hormone (T4)

Thyroxin (T_4) values decreased significantly due to heat stress conditions of summer season as compared with winter and the percentage decrease was 14.77 in native bovine calves and was 15.29 in F1(½ brown Swiss x ½ Native cows) calves. T_4 level was not affected significantly due to experimental group under each of winter and summer season (Table 5).

Triiodothyronine (T3)

Triiodothyronine ($T_{3)}$ values were found to be significantly lower in summer than in winter (Table 5). The percentage decrease was 0.94 ng/ml (32.21%) in native bovine calves and was 0.67 ng/ml (17.31%) in F1(½ brown Swiss x ½ Native cows) calves. These results showed that F1 calves were less affected by hot climatic condition in T_3 hormone than native bovine calves although T_3 level was not affected significantly between the two experimental groups under each of winter and summer season (Table 5).

Cortisol hormone

Cortisol level was significantly higher during summer than those in winter in both native bovine calves (+ 4.92 ng/l; 31.74%) and F1 calves (+ 4.29 ng/ml; 27.3%). Results also illustrated that F1calves were less affected by climatic condition in cortisol than native bovine calves although cortisol level was not affected significantly between the two experimental groups under each of winter and summer season (Table 5).

Table5. *Effect of heat stress conditions of hot summer season and crossing on thyroid and adrenal hormonal levels.*

Hormonal levels	Winter season		Summer season	
	Native cattle calves	**F1 (½ brown Swiss x ½ Native cattle) calves**	**Native cattle calves**	**F1 (½ brown Swiss x ½ Native cattle) calves**
T_4 (ng/ml)	71.23^a ±3.86	74.76^a± 4.04	60.71^b±3.12	63.33^b ± 3.42
Effect of heat stress of summer			-10.52 ng/ml	-11.43 ng/ml
Change % due to HS			(-14.77%)*	(-15.29%)*
Change due to crossing	(+3.53 ng/ml)^{NS}		(+2.62 ng/ml)^{NS}	
T_3 (ng/ml)	4.05^a ± 0.24	3.87^a± 0.08	3.11^b± 0.14	3.20^b± 0.12
Effect of heat stress of summer			0.94 ng/ml	0.67 ng/ml
Change % due to HS			(- 23.21%)**	(-17.31%)**
Change due to crossing	(-0.18 ng/ml)^{NS}		(+0.09 ng/ml)^{NS}	
Cortisol (ng/ml)	15.50^b±0.78	15.87^b±0.84	20.42^a±0.85	20.16^a±1.21
Effect of heat stress of summer			+4.92 ng/ml	+4.29 ng/ml
Change % due to HS			(+31.74%)***	(+27.30%)***
Change due to crossing	(+0.37 ng/ml)^{NS}		(-0.26 ng/ml)^{NS}	

Different letters indicate significant differences (a > b > c > d),

NS=Not significant, **= Significant at P<0.05,* ***= Significant at P<0.01 and* ****= Significant at P<0.001*

Values are expressed as mean ± SE.

DISCUSSION

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Growth performance

Due to heat stress conditions of hot summer season, averages of total live gain values in 90 days deceased 23.52 kg in native bovine calves and 32.87 kg in F1 calves. Daily live body weight gain values decreased 261.3 g in native bovine calves and 365.0 g in F1. Total solids gain in 90 days decreased 6.98 kg in native bovine calves and 8.71 kg in F1 calves. Daily solids gain values decreased 77.4 g in native bovine calves and 97.0 g in F1 calves (Table 3)

Table (2) showed that average of THI was 69.02 during winter and was 89.35 during summer indicating that the two experimental calves were exposed to severe heat stress during summer season and absence of heat stress during winter season. The adverse effect of high ambient temperature on animals live and solids gain may be due to a decrease in DMI and feed efficiency as shown in Table (4). In addition, the decrease gain of heat stressed calves may be due to increase cortisol and decrease thyroid hormonal levels as presented in Table (5).

Crossing between ♂brown Swiss with♀ native cows improved significantly total live gain and total solids gain values in 90 days by 26.9 kg and 9.22 kg in winter and 17.6 and 7.49 kg in summer, respectively. Accordingly, daily live body gain and daily solids gain values were higher in F1 calves than in native bovine calves by 299.0 g and 102.4 g during winter season and by 195.3 g and 82.8 g during summer season, respectively (Table 3). From the results in this research it confirmed that crossbred calves are better in live and solids gain than purebred calves under two climatic conditions.

The aim of cross breeding is to transmit the superior phenotypic characteristics of brown Swiss breed to the first generation offspring (F1). The results in Table (3) indicate that growth traits of F1 calves (crossbred group) are higher than those of the parent purebred (native bovine calves). This improvement in growth performance in F1 calves may be due to heterosis in the offspring. The use of exotic breed (brown Swiss) for crossing with native bovine cows is to take advantage of hybrid vigor and to take advantage of appropriate combinations of the superior traits of two different breeds.

Genotype crossing influences growth performance of cattle (Jenkins and Ferrell, 2004; Sanders et al., 2005; Haque et al., 2011). The highest values in body weight at birth and at weaning were reported by grading up native cows with Friesian or Brown Swiss bull and that superiority mainly due to heterosis in growth rate of the offspring and additive gene effect for growth and adaptation characteristics (Norris et al.. 2002). Early in Egypt, EL-Fouly et al. (1998) considered crossing with Brown Swiss bull has effective for improving low producing native cattle. In this respect, Habeeb et al. (2012 and 2014) reported that genotype of crossbred (Brown Swiss bull x Native cow) calves is more favorable than those found in purebred calves because cross calves have a good structure and type of genes that collected in pure Brown Swiss bull and transported into native calves. Concerning the adaptability, Holstein crossed with local breeds in the tropics and subtropics perform better than the purebred Holstein and were also resistant to heat stress (Molee et al., 2011).

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Water Intake

Water intake values in Egyptian native bovine calves and F1 (½ brown Swiss x ½ Native cows) calves were significantly higher during summer than those during winter with percentage increase 63.9 in native bovine calves and 66.5 in F1 calves without significant difference between the two experimental groups (Table 4).

Temperature is the most important environmental factors controlling water intake in farm animals. Exposure of calves to high environmental temperature during hot summer season stimulates the nerve impulses to the thirst center in the hypothalamus to increase the defensive evaporative and non-evaporative cooling systems by stimulating the sweat glands to cause evaporative heat loss from the skin and stimulating vasodilator nerves to the skin thereby increasing the transport of the heat by the blood to the body surface (Habeeb et al., 1992) This thermoregulatory process increased the water loss from body of heat stressed calves (Rasby and Walz 2011). Calves under hot summer season also tend to have increased water content in the rumen as a result of an accelerated water turnover rate (Gonzalez et al., 2010) and prevent dehydration and allows heat to dissipate through sweating and urination (Chicester and Mader, 2012). In addition, water is also has high specific heat which promotes heat dissipation (Marai and Habeeb, 2010a). Therefore, water intake in animal increases significantly under heat stress conditions.

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Dry Matter Intake

Dry matter intake (DMI) was significantly lower during summer than those during winter in both two experimental groups. The percentage decrease was 22.5 in native bovine calves and was 24.8 in F1 (½ brown Swiss x ½ Native cows) calves without significant difference in between the two experimental groups (Table 4).

Depression in feed consumption is the most important reaction to heat exposure. Exposure calves in two experimental groups to high ambient temperature during summer season stimulates the nerve impulses to the appetite centre in the hypothalamus causing the decrease in feed consumption, i.e., dry matter intake (Table 4) to minimize thermal load on animals.

In addition, the disturbance occurs in hormonal secretion where decrease in each of T_4, T_3 as anabolic hormones and increase of cortisol as catabolic hormone (Table 5). Such disturbances lead to depression in some of the blood metabolites and the final result of these changes is impairment of appetite, feed intake, feed efficiency, food utilization and consequently growth.

The decrease in fed intake is an attempt to produce less metabolic heat, as heat increment of feeding which is a protective mechanism (Kadzere et al., 2002). Animals typically react to heat stress conditions by eating less food, thus naturally controlling the rise in deep body temperature caused by digestion (Marai and Habeeb, 2020b). Similar results in farm animals reported by Shwartz et al. (2009) and Bernabucci et al. (2010).

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Feed Conversion

The results indicate that poorer feed efficiencies occur in calves of two experimental groups under hot summer season. Table (4) show that each calf saves about 2.5 kg DMI in winter and 4.0 kg DMI in summer to obtain one kg live gain. F1 calves are better in FC than native bovine calves under the two climatic conditions due to improvement of gain in F1 calves. This improvement may be due to that F1 calves were more efficient in metabolism and adsorption process of nutrients (EL-Fouly et al., 1998). Norris et al. (2002) reported also that DMI was higher in all the crosses than in purebred Brahman animals and consequently fed conversion improved due to crossing.

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Thyroid Hormonal Levels

T_3 and T_4 values in calves in both two experimental groups were found to be significantly lower in summer than in winter without significant difference between the two groups. Exposure calves to severe heat stress conditions of hot summer season suppresses the production of hormone releasing factors from the hypothalamic centers causing a decrease in pituitary hormonal secretion and lowers the secretion of thyroid stimulating hormone and consequently lower the secretion of thyroid hormones (Habeeb et al., 1992). The decreases in thyroid hormones are consistent with the decrease in metabolic rate, feed intake and growth under heat stress (Habeeb et al., 2014). Moreover, the reduction in thyroid activity in animal under severe heat stress conditions of hot summer season is the process of adaptation to its environment (Silanikove, 2000). Hormonal secretions are known to be of major importance in body thermoregulation, especially thyroid hormones, either T_4 or T_3 play an important role in animal's adaptation to environment changes (Horowitz, 2001).

Effect of Heat Stress Conditions of Hot Summer Season and Genetic Crossing on Cortisol Hormonal Levels

Cortisol levels were significantly higher during summer than those in winter by 4.92 and 4.29 ng/ml in native bovine calves and F1 calves, respectively, without significant difference between the two experimental groups (Table 5). The increase in cortisol level as a catabolic hormone in calves exposure to acute severe heat stress conditions during hot summer season may be due to the effect of stressful conditions on adrenal gland to increase cortisol as glucocorticoid hormone which has hyperglycaemic action to increase gluconeogenesis process to provide the expected increase in glucose utilization in heat stressed calves (Habeeb et al. 1992 and Marai and Habeeb, 2010 a, b).

It is can be concluded that heat stress conditions of summer season in Egypt had adversely effects on both live and solids gain as well as hormonal levels in both native bovine and F1 (½ brown Swiss x ½ Native cows) calves. In addition, F1 calves were better than native bovine calves in both live and solids gain under both winter and summer seasons. Finally, it can be concluded that Brown Swiss bull when crossed with local bovine cows produced offspring in 1st generation better than the native local bovine calves under both winter and summer seasons.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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