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Studying Resistance of Some Dairy Cattle Breeds to Heat Stress in Relation to Milk Yield

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Abstract: The objective for our work was to estimate the milk yield and blood biochemical constituents of and weight daily gain of calves recently born from imported cows under hot summer conditions in Egypt. Thirty late- pregnant cows, aged 22-24 months, chosen randomly were used in this study. Experiment was carried out during the period from third stage of pregnancy and continued to 8 weeks postpartum. Imported late-pregnant cows divided into three groups, each group was 10 cows. 1st group was Brown Swiss (BS) cows, 2nd group was Simmental (S) cows and 3rd group was Holstein (H). Results showed that H cows have a lowest rectal temperature (RT) and respiration rate (RR) in compare with BS and S cows. Results showed that H cows have a highest daily milk yield while S cows have lowest values. BS and H cows have significantly higher total protein, albumin and urea concentrations than S cows. While, globulin and glucose concentrations were significantly higher in BS than its concentrations in S and H cows, respectively. Total cholesterol, phospholipids and creatinine concentrations showed the lowest values in BS cows as compare with S and H cows. Otherwise, BS cows have the highest triglycerides concentration as compare with H and S cows. About liver function showed the highest activity for AST in S cows and for ALT in H cows as compared of other groups. BS cows have significantly higher T4 and Estradiol17β levels than its levels in S and H cows, respectively. Birth weight of newborn both male and female calves as well as daily body weight gain of calves produced from the three imported cows were not differs Significantly. Two months weight of calves produced from S cows was significantly higher than BS and H cows, respectively. In conclusion, the three imported breed cows appears good resistance to heat stress effects under hot summer conditions in Egypt with extremely resistance for H cows.

Keywords: Imported Cows, Heat Stress, Milk Yield

1. Introduction

Animal protein is considered the most essential element in food security problem in Egypt due to restricted Production increase of livestock sources and depended on incoming from abroad [1]. So that, it is needed to be careful about Milk production steps to fill the nutritional gap of animal protein. Milk is the second most important contributor to animal production (26.66% of the total animal Production) ˙Milk contributes greatly to meeting the body's needs for calcium, magnesium, selenium, riboflavin and vitamin B12. Therefore, milk is considered Perfection product because it contains most of the nutrients that supply the human body with almost all food and vital requirements [2].

Dairy cattle in Egypt play an essential role for improving human nutrition and national income. Milk Production of local cows is extremely lower than that of higher ranking breeds. Therefore, Egypt has been suffering from a severe insufficiency in milk and dairy products. The consequences of climate change become, in the last few decades, more and more expressed worldwide. In accordance with the Intergovernmental Panel on Climate Change [3], which make dairy cattle exposed to unfavorable climatic conditions, even in regions that now are not characterized by climate extremes.

Numerous studies showed that high producing cows were much more susceptible to heat stress than low producing cows [4&5]. Especially imported breeds of the regions that not-classified as climate extremes. The genetic relationship between temperature-humidity index and productive traits of imported dairy cattle was found in few studies [6]. On the other hand, the presence of high yielding Holstein cows in Israel demonstrated a good example that selective production could be successful in terms of heat stress [7]. So that, implementation of breeding values for heat resistance in breeding strategies would certainly reduce financial losses of dairy farmers [8].

Considering, the above circumstances, the Objective of this work was to study and evaluate the resistance of different imported cattle breeds to heat stress side effects under hot summer environmental conditions in Egypt by brief evaluate to physiological response, blood biochemical components and hormones in relation to milk yield.

2. Materials and Methods

The present study was carried out in the El-Khaer and El-Baraka farm in El-Salhya desert area, El-Sharkia Governorate, Egypt.

2.1. Animals Feeding

The ration and fresh drinking water were available to all animals at all times. The animals were fed in groups. The concentrate feed mixture (CFM) and corn silage were presented according to NRC [9], to covering the requirements of dairy cattle, by the percentage of (corn silage 60% and CFM 40%), in approximately 14-15 kg total ration. Samples of corn silage and CFM were (biweekly) collected. Samples were ground in a hammer mill provided with a 1-mm pore size screen and analyzed in triplicate for their content in DM (forced-air oven at 65°C and dried to a constant weight), ash, CP (N × 6.25), crude fibre (CF), ether extract (EE) according to AOAC [10]. Nitrogen free extract (NFE) was calculated by differences. The Ingredients of CFM are shown in Table 1. The chemical compositions and nutritive values of the experimental feedstuffs on dry matter basis are shown in Table 2.

2.2. Experimental Design

Thirty late-pregnant imported cows at first pregnant, aged 22-24 months, chosen randomly from imported herd from Slovenia were used in this study. This work was carried out for a period of five months from the third stage of pregnancy (three months before birthing) to calving and continued until 8 weeks postpartum. Imported late-pregnant cows divided into three groups, each group was 10 cows. 1st group was Brown Swiss (BS) cows, 2nd group was Simmental (S) cows and 3rd group was Holstein (H). All cows breed were keep going under the same feed and farmer's management system. The body weight at delivery time (at birth) and after 4 and 8 weeks from birthing recorded for calves in the three experimental groups. The average of daily weight gains of calves were also calculated from birthing to 8th week's age. The calves were left with their mothers all time to suckling their milk. Milk yield was estimated after 1st, 4th and 8th weeks postpartum for all of cows in the different groups, by recording the daily morning and evening circuit.

RT and RR were followed up as a physiological response to heat stress by using a clinical thermometer inserted into the rectum to three inches and left for two minutes for RT, and by counting the flank movement for a period of one minute using stop watch for RR, while, its measurement was carried out before measuring the RT to avoid animal excitation.

Table 1. *Ingredients of the concentrate feed mixture (CFM).*

Items	CFM
Ingredients (%)	
Crushed yellow maize	40
Wheat bran	25
Soybean meal	5
Undecorticated cotton seed meal	27.5
Lime stone	1
Sodium chloride	1
Minerals mixture*	0.1
Vitamin mixture**	0.1
Sodium bicarbonate	0.2
Antitoxin	0.1

* mineral mixture contains: 5g Cu, 30g Fe, 40g Mn, 45g Zn, 0.3g I, 0.1g Se and 881.6g Caco3/ kg mixture.
**vitamin mixture contains: 20 million (I. U) vit A, 2 million (I. U) vit D3 and 2g vit E / kg mixture.

Table 2. *The chemical compositions and nutritive values of the experimental feedstuffs on dry matter basis (DM).*

Items	CFM	Corn Silage
Chemical composition (%):		
Moisture	12.4	70.52
Dry matter (DM)	100	100
Organic matter (OM)	94.1	92
Crude protein (CP)	16.8	10.56
Crude fiber (CF)	8	24
Ether extract (EE)	2.6	2.6
Ash	5.9	8
Nitrogen – free extract (NFE)	66.7	54.84
Nutritive values:	CFM	Corn Silage
GE (Mcal/kg DM)*	3.9	3.12
NE (Mcal/kg DM)**	1.37	1.1
TDN (%/kg DM)**	60.82	49.8

% NFE=% DM - (% EE +% CP +% ash +% CF) *, GE (Mcal/kg DM)=0.057 CP% + 0.094 ether extract (EE)% + 0.0415 carbohydrate% (NRC, 2001); **, NE (Mcal/kg DM)=0.0245 X TDN% - 0.12 (NRC, 2001);***, TDN (%/kg DM) according to the Central Lab for Food and Feed (CLFF), Agric. Res. Center, Egypt (2001).

2.3. Animal's Management

Each breed of imported pregnant cows was placed separately in a different barn, where they were left free loose throughout the day and night, and the barns were on sandy floors (40x40 m) surrounded by wire fence (1.5 m height). One-third of the surface area of the barn was covered with fixed roofing shad in the center (3.5 m height) with natural ventilation. Each barn was as long as with basin as permanent source of drinking water all day long to the calves.

2.4. Meteorological Data

This experiment was carried out during summer season period, from May to September, 2016, air temperature (AT) and the relative humidity (RH) during day and night were recorded in the farm area, which collected from the nearest meteorological station. These data were used to calculate the daily temperature humidity index (THI), and the average of each item was calculated, where the AT and the RH during the days times averaged 38.70°C±0.33 and 61.55%±0.74, (equivalent to THI 92). While the average of AT was 29.10°C±0.24 and in RH was 80.34%±0.71, (equivalent to THI 81) during the night times. THI was calculated using the following equation [11]: where, THI=(0.8× AT°C) + [(RH%) × (AT°C -14.4)/100)] + 46.4.

2.5. Blood Sampling and Biochemical and Hormonal Analysis

Blood samples collected monthly before and after parturition, one fasting blood sample was taken from each cow from the jugular vein by jugular venipuncture using one use syringes. Serum was separated from clotted blood by centrifugation (20 min, 3000 × g) and purified serum was collected and stored at -20°C until serum biochemical and hormonal measurements. All estimated parameters were measurements by using commercial kits manufactured by Diamond Diagnostic Company (Egypt), unless otherwise noted.

These parameters were total protein, albumin, glucose, total cholesterol and triglycerides. Urea-N and creatinine were estimated to assess the functional state of the kidneys. Liver enzymes activities, aspartate amino transferase (AST) and alanine amino transferase (ALT) determined also. Globulin value was calculated by subtraction of albumin value from their corresponding total protein value. Serum phospholipids was calculated by using the following equation:

Phospholipids=68 + (0.89×Total cholesterol), [12].

T4 and Estradiol17β (E2) hormones were determined by using ^{125} I-RIA technique and antibody-coated tubes kits purchased from Immunotech Beckman Coulter, Inc., Prague, Czech Republic, Europe. Samples were assayed in duplicate as described by method source and the radioactivity is determined in computerized gamma counter.

All measurements were carried out in the tracer bioclimatology unit, Department of Biological Application, Nuclear research center, Atomic Energy Authority, Inshas, Cairo, Egypt.

2.6. Statistical Analysis

Data were statistically analyzed using the general linear model procedure of GLM ANOVA procedure of SAS [13]. The statistical model used was: $Y_{ij}=\mu + T_i + e_{ij}$, Y=the dependent variable, μ=the overall mean, Ti=the fixed effect of breed (1=Brown Swiss, 2=Smintal, 3=Holshtein), e_{ij}=random error. Significant differences between the means were verified by Duncan [14].

3. Results

3.1. Physiological Responses

Data of physiological responses are shown in Table 3. H cows recorded a significant (*P*<0.001) lower values of RT and RR in 39.48°C and 41.40 breath/min, respectively in compare with BS and S cows which recorded 40.10 and 40.07°C for RT, respectively and 44.40 and 42.90 breath/min for RR, respectively, as shown in (Table 3).

Table 3. *The changes in physiological responses in Brown Swiss, Smintal and Holshtein cows under hot summer conditions.*

items	Brown Swiss	Smintal	Holshtein	P-value
Rectal temperature (°C)	40.10 a±0.12	40.07 a±0.08	39.48b±0.07	0.001
Respiration rate (breath/ min)	44.40a±0.56	42.90ab±0.57	41.40b±0.37	0.001

a, b Means within rows with different superscript are significantly different

3.2. Proteins and Glucose

Data about proteins concentrations are shown in Table 4. BS and H cows have significantly (P<0.01) higher total protein and albumin concentrations with 6.40 and 6.22 g / dL for total protein, 4.38 and 4.50 g / dL for albumin, respectively, and also, A / G ratio with 2.18 and 2.68, respectively, than S cows which recorded the lowest mean values of the above parameters. While, globulin concentration was significantly (P<0.01) higher in BS cows with 2.02 g / dL than its concentrations in S and H cows with 1.90 and 1.72 g / dL, respectively. (Table 4). A significant (*P*<0.001) highest concentration of glucose is shown in BS cows with 63.70 mg / dL as compare with S and H cows with the mean values of 58.30 and 53.30 mg / dL, respectively as shown in Table 4.

Table 4. *The changes in proteins and glucose concentration in Brown Swiss, Smintal and Holshtein cows under hot summer conditions.*

items	Brown Swiss	Smintal	Holshtein	P-value
Total protein (g / dL)	6.40a±0.06	5.79b±.11	6.22a±0.5	0.01
Albumin (g / dL)	4.38a±0.02	3.89b±0.13	4.50a±0.7	0.01
Globulin (g / dL)	2.02a±0.05	1.90ab±0.8	1.72b±0.07	0.01
A / G	2.18a±0.05	2.10a±0.15	2.68b±0.17	0.01
Glucose (mg / dL)	63.70a±0.37	58.30b±0.42	53.30c±0.72	0.001

a, b, c Means within rows with different superscript are significantly different

3.3. Liver Function

Data of liver function are shown in Table 5. A significant (P<0.001) highest activity for AST is shown in S cows with 32.10 U / mL as compare with BS and H cows with mean values of 23.60 and 18.60 U / mL, respectively. And, ALT showed significantly (P<0.001) highest activity in H cows with 13.00 U / mL as compare with BS and S cows with mean values of 11.50 and 11.00 U / mL, respectively. (Table 5).

3.4. Kidney Function

Data of kidney function are shown in Table 5. A significant (P<0.001) lowest concentration of urea is shown in S cows with 24.20 mg / dL as compare with BS and H cows with the same mean value of 32.50 mg / dL. while, creatinine showed significantly (P<0.001) lowest concentration in BS cows with 1.40 mg / dL as compare with S and H cows with mean values of 1.55 and 1.72 mg / dL, respectively. (Table 5).

Table 5. *The changes in liver and kidney functions in Brown Swiss, Smintal and Holshtein cows under hot summer conditions.*

items	Brown Swiss	Smintal	Holshtein	*P-value*
AST (U / mL)	23.60^{a}±0.75	32.10^{b}±0.50	18.60^{c}±0.37	0.001
ALT (U / mL)	11.50^{a}±0.34	11.00^{a}±0.26	13.00^{b}±0.47	0.001
Urea (mg / dL)	32.50^{a}±0.58	24.20^{b}±0.42	32.50^{a}±1.37	0.001
Creatinine (mg / dL)	1.40^{a}±0.04	1.55^{b}±0.05	1.72^{c}±0.02	0.001

a, b, c Means within rows with different superscript are significantly different

3.5. Lipids Profile

Data about lipids profile are shown in Table 6. Total cholesterol and phospholipids concentrations were decreased significantly (P<0.001) with the lowest mean values in BS cows group in 78.0 and 137.42 mg / dL, respectively, as compare with S and H cows groups with the mean values of 102.20 and 97.50 mg / dL for total cholesterol, respectively, and 158.96 and 154.78 mg / dL for phospholipids, respectively. Otherwise, S cows have a significant (P<0.001) lowest mean value of triglycerides concentration of 74.80 mg / dL as compare with H and BS cows with the mean values of 76.60 and 99.10 mg / dL, respectively. (Table 6).

3.6. Hormones

Data of hormones levels are shown in Table 6. T4 and Estradiol17β levels were increased significantly (P<0.001) with the highest mean values in BS cows group with 117.99 and 226.07 ng / mL, respectively, as compare with S and H cows groups with the mean values of 101.45 and 96.91 ng / mL for T4 level, respectively, and 205.40 and 183.05 ng / mL for Estradiol17β level, respectively. (Table 6).

Table 6. *The changes in hormones and lipids profile in Brown Swiss, Smintal and Holshtein cows under hot summer conditions.*

items	Brown Swiss	Smintal	Holshtein	*P-value*
T4 (ng / ml)	117.99^{a}±0.39	101.45^{b}±0.52	96.91^{c}±0.23	0.001
Estradiol (ng / ml)	226.07^{a}±0.63	205.40^{b}±0.65	183.05^{c}±0.68	0.001
Cholesterol (mg / dL)	78.00^{a}±1.15	102.20^{b}±0.89	97.50^{c}±0.96	0.001
Triglycerides (mg / dL)	99.10^{a}±0.82	74.80^{b}±0.61	76.60^{b}±0.83	0.001
Phospholipids (mg / dL)	137.42^{a}±1.02	158.96^{b}±0.79	154.78^{c}±0.85	0.001

a, b Means within rows with different superscript are significantly different

3.7. Productive Performance

Data of Productive performance are shown in Table 7. Results showed that H cows recorded a significantly (P<0.001) highest daily milk yield for twice milking time (morning and evening) of 38.20 kg / day, while S cows have lowest mean value 24.20 kg / day. Whereas, BS presented an intermediate mean value of 29.20 kg / day. Both, male and female newly born calves for the three imported cows in our study showed insignificantly different in birth weight and daily body weight gain also. But, two months weight of calves produced from S cows groups with mean value of 61.40 kg was significantly (P<0.01) higher than BS and H cows group with the mean values of 59.70 and 56.50 kg, respectively. (Table 7).

Table 7. *The changes in milk yield and new-born birth weight and daily gain in Brown Swiss, Smintal and Holshtein cows under hot summer conditions.*

items	Brown Swiss	Smintal	Holshtein	*P-value*
Milk yeild (kg / day) Morning	14.90^{a}±0.60	12.10^{b}±0.43	19.00^{c}±0.37	0.001
Milk yeild (kg / day) Evening	14.30^{a}±0.42	12.10^{b}±0.53	19.20^{c}±0.53	0.001
Birth weight (kg)	31.40±0.90	33.70±0.79	31.00±0.88	0.073
Two month weight (kg)	59.70^{ab}±1.01	61.40^{a}±1.13	56.50^{b}±1.40	0.012
Daily gain of calves (kg/day)	0.472±0.02	0.478±0.02	0.425±0.02	0.097

a, b, c Means within rows with different superscript are significantly different

4. Discussion

4.1. Physiological Responses

Different physiological responses involve in thermoregulation. RT, high respiration rate RR, vasodilatation with increased blood flow to skin surface, reduced metabolic rate, decreased dry matter intake and altered water metabolism so, these physiological responses have negative impact on the production and reproduction of the imported cows [15].

RT is generally considered as a good index of deep body temperature even though there is considerable variation among different parts of the deep body core at different times of the day [16], and the changes in core body temperature cause the hypothalamus to send nerve impulses to the sweat glands, muscles and blood vessels to raise or lower the temperature. If the core temperature goes up the body loses heat to bring it down again. If the core temperature goes down the body will conserve and even generate heat to bring it up again. Change in rectal temperature has also been considered an indicator of heat storage in animal's body and may be used to assess the adversity of thermal environment, which can affect growth, lactation and reproduction of dairy animals [17].

In agreement of our results heat-stressed Holstein cows were able to maintain their acid-base balance with a marginal change in their pH, when their rectal temperatures increased. And also, the magnitude of increase in RT during heat stress was lowest in Holstein followed by Jersey cows. So, Holstein cows appear to be able to maintaining their normal body temperature under heat stress conditions and these observations suggest that they are heat adaptable breed. Furthermore, the magnitude of increases seen in respiration rate due to heat stress was similar to the changes was seen in RT [18].

The semi-arid climate is not suitable for Brown Swiss cattle because air temperature and relative humidity contribute to form a hostile environment, as shown by the temperature-humidity index values [19]. On the other side, Different researchers indicated that Brown Swiss (Br) cows are less sensitive to hot environment exposure than Holstein (Ho) cows. While, Brown Swiss cows had a lower rectal temperature than Holstein cows in three treatment groups which supports that Brown Swiss cows were more resistant to heat stress than Holstein cows [20].

4.2. Proteins and Glucose

Significant decrease in total protein concentration has been accounted during heat stress [21]. The total plasma protein, albumin, globulin decreased in Baladi goats subjected to short term heat stress for two days. This may be due to increase in plasma volume as a result of heat shock which causes results in decreases plasma protein concentration. Prolong exposure of solar radiations was found to elevate the plasma level of total protein, albumin, and globulin. This might be due to vasoconstriction and decreased plasma volume during heat stress [22].

Total protein and albumin concentrations were significantly influenced by breed genotype, while, the two previous parameters levels were significantly higher in H and BS cross cows than in local (L) cows [23]. The authors attributed higher levels of total protein and albumin in crossing cows to better thyroid hormonal levels in it, which agreement with our results while highly total protein and albumin levels in H and BS cows matches with the highly T4 concentration as shown in Table 6.

Serum glucose is a good physiological adaptation mechanism that can be affected by high ambient temperatures. Greater variations are observed in level of blood glucose in hot conditions than in the thermo-neutral zone. Further, some researchers reported that hot climatic conditions are responsible to reduce blood glucose [24], showed decrease of blood glucose level during summer season in goats with opposite trend and increases during winter season [25].

Plasma glucose increased recorded in Holstein cows as compared with Jersey cows under heat stress in agreement with our results and it is postulated that the increased energy demand associated with increased respiratory rate, along with possible decrease in feed intake, may have caused some mobilization of the body fat reserves to increase the plasma glucose levels in Holstein cows [18].

4.3. Liver Function

Metabolic regulators are important in elucidating a picture of modulation in physiological mechanisms during stressed conditions and are best assessed by determining the enzymes governing various metabolic reactions in plasma or serum. Metabolic activities of individual are well reflected by levels of these enzymes in serum. Therefore, during stress condition, the enzymatic activities vary from the animal in comfort zone [22].

Serum level of AST and ALT is helpful in diagnosis of welfare of animals. Serum ALT value found to be increased during heat stress in goats, with no significant changes were observed in AST level in goats during heat stress [24&26]. Likewise, the noticeable increase in AST and ALT activities under hot condition was recorded in cows [27], which may be attributed to the impaired function of the liver under heat stress [28].

In accordance of our results heat stressed Holstein cows showed markedly decreased in AST under heat stress conditions and clinical serum enzymatic activity was measured to assist in the overall evaluation of the health status of these animals [18].

4.4. Kidney Function

Heat stress increased plasma urea–N concentration in lactating Holstein cows [29]. Particularly, Montmurro [30] suggested that the high level of urea was due to the low energy/protein ratio and to gluconeogenesis by protein degradation in conditions of insufficient energy for growth, and indicated that urea is normally higher when protein is in excess in the diet or there is a low energy / protein ratio.

In agreement of our finding the high level of urea in BS and H than S cows level, may be because the highly protein metabolic efficiency of food nutrition in these cows than others. While, the urea as the end product of protein metabolism increased in BS and H than S cows [23]. Moreover, H herd had the lowest BUN concentrations, which could suggest that HF cows are more prone to incur metabolic disorders than other breeds. BS and S showed different BUN concentrations in highly compare with H cows [31]. In fact, low BUN commonly indicates an insufficient energy and protein intake due to the diet or inability of the animal to cope with the NEB that characterizes the first month of lactation [32]. Similar BUN concentrations were found among BS, HF, and SI breeds [33].

On the other hand, the significant decrease in blood urea nitrogen and an increase in creatinine in Heat stressed Holstein cows as a result of heat stress indicate that the kidneys are unable to perform their normal function. The decrease in BUN may be associated with decreased feed intake or utilization of body proteins by the fetus. The rate of excretion of CR is influenced by the glomerular filtration rate and CR is eliminated more easily than BUN. Heat stress is known to cause peripheral vasodilatation to allow loss of body heat through sweating and can therefore reduce the blood flow to the internal organs. In addition, dehydration can also result in reduced blood flow to the kidneys [18].

4.5. Lipids Profile

Total serum cholesterol levels are physiological adaptation mechanism that can be affected by high ambient temperatures. Greater variations are observed in level of serum total cholesterol in hot conditions than in the thermo-neutral zone. Further, some researchers reported that hot climatic conditions are responsible to reduce total serum cholesterol levels, while cold climate increase it [24 &34]. On contrast, serum levels of cholesterol and triglycerides were higher during summer compared to respective winter values [35].

In disagreement with our results *Qu* [36] indicated that during heat stress, high yielding cows had a greater level of plasma total cholesterol and triglycerides, and suggests that high-yielding cows may derived more triglycerides from the liver helping to maintain milk production or milk fat during the heat stress, leading to increased milk fat content for these cows than low-yielding cows, while, in the present study S and BS cows recorded high level of total cholesterol and triglycerides, respectively, as compared to H cows which achieved higher productivity in milk yield.

Also, the high level of cholesterol in cows maintained under heat stress could reflect the lower secretion of thyroxin in a common finding for animals suffering from heat stress as a mechanism for lowering the metabolic heat production, in disagreement with our results while, BS cows which have highest level of thyroxin, showed the lowest concentration of total cholesterol and in the same time have highest concentration of triglycerides [37].

In agreement with our results for cholesterol concentrations in H cows, the significant decrease in total cholesterol has been reported by *Tainturier* [38] in Friesian cows at the end of pregnancy, and attributed that to the role of the compound in ovary steroidogenesis, so the total cholesterol concentrations are under control of the complex of factors [39]. And also, the well estimated decline in total cholesterol level in H cows compared to another imported breeds in our study may have a relation with significantly increase in total body water under heat stress [40], or this decline may be attributed to the decrease in fat content in H cow milk which have highly production of milk yield in a negative correlation between milk yield and fat content. Furthermore, fat content on the basis of daily milk was significantly lowest in Holstein breed as compared to other cattle breeds [41].

4.6. Hormones

Heat stress reduces plasma concentrations of estradiol-17β and lower follicular estradiol concentration, and also, delay ovulation, while, the mechanisms by which heat stress alters the concentrations of circulating reproductive hormones are not known. Some effects of heat stress may involve adrenocorticotropic hormone (ACTH) and increase cortisol secretion, while ACTH has been reported to block estradiol-induced sexual behavior [42].

It has been shown that heat stressed animals showed reduce in thyroid activity as compared to winter conditions which increased thyroid activity [43]. It is reported that heat stress decreased plasma T3 and T4 levels during the summer season helps the animals to decrease the endogenous heat production to tolerate the heat [44].

In accordance with our results which suggested high level of T4 and Estradiol17β in pure BS breed. T4 and Estradiol17β showed significantly higher concentrations in crossbred cows either H or BS than those observed in Local cows. While, the high levels of T4 and Estradiol17β in crossbred cows both, H and BS may be attributed to the increases in the demands of these hormones for regulatory mechanism of processes of high milk yield in crossbred cows [23].

4.7. Productive Performance

The diversity in daily milk yield may be due to the variation in Genetic makeup of several breeds of cows used in the present work. Highest milk yield was observed for Holstein cows are the highest milk producing dairy breed, which is imported by many developing countries mostly of tropics and subtropics, either for keeping it as pure breed or for crossing with the local low producing cattle from technologically developed countries of temperate zones [45].

Holstein Friesian cows, among other imported dairy breeds, contribute significantly to milk production and dairy industry in Egypt. However, importation of European dairy breeds in Egypt is followed by unsatisfactory performance under tropical conditions [46]. So, in agreement with our results, reviewed literature reported that milk production was obviously high in Holstein maintained under temperate environmental conditions [47]. Furthermore, H crossbred cows have a highest daily milk yield and then BS crossbred cows when compared with L cows which have a lowest daily milk yield [23]. So that, Holstein is imported to improve the national milk production under the tropical and subtropical environmental conditions [48].

On the other hand, even in tropical southern United States, Holstein suffered great loses in terms of milk production, fertility and reproduction, although, immediate and special efforts were made to control environmental influences. Dairy cattle in southern USA, exposed to hot conditions during late gestation produced calves with lower birth weights, and produced less milk than cows not exposed to hot conditions [49].

Among the European cattle breeds, the Brown Swiss is one of the most tolerant to heat, with a black skin that absorbs ultraviolet radiation well, and a clear hair that reflects infrared radiation well, characteristics necessary for a good tolerance to heat [50&51], which support their highly production in milk yield under heat stress conditions in our results.

Multiparous cows seemed to be more resistant to heat stress than primiparous, while Simmental cows seemed to be more resistant to heat stress than Holsteins. However, the question still remains are Simmentals more heat stress resistant? Is the supposed resistance found in this research mainly a consequence of the lower production level of Simmentals or are they genetically more appropriate for the expected challenges in the future milk production? These questions will be answered by subsequent researches [8]. So, in the same author later search and in agreement of our results Simmental animal production is characterized by high animal productivity and, in the same time considered as low stress resistance animal as shown in their milk production under heat stress [52].

5. Conclusion

Implementation of breeding values for heat resistance in breeding strategies would certainly reduce financial losses of dairy farmers. In conclusion, the imported breed cows used in the present work (BS, S and H) appears good resistance to heat stress side effects under hot summer environmental conditions in Egypt with extremely resistance for H cows, in a recommendation to useful from this breed genotype adaptability to climate extreme for covering the shortage of milk production in Egypt.

Conflict of Interest

The authors declare that they have no conflict of interest.

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