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Impact of chronic heat stress on physiological and productive performance of buffalo dams during the dry period under climatic conditions in the Nile Valley

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ABSTRACT

The present study was conducted at Bani Sweif Governorate (The middle area of the Nile Valley). The experimental work was carried out at Seds Experimental farm affiliated with the Animal Production Research Institute (APRI), Agricultural Research Center (ARC). The main objective of this work was to study the impact of exposure of buffalo dams to direct solar radiation at late pregnancy (Two months dry period) on physiological and productive performance. Also, to study the Comprehensive Climate Index (CCI) under Egyptian conditions with the higher solar radiation that characterizes the Nile Valley in comparison with the temperature-humidity index (THI) which is still the proper indicator of animal stress under the environmental conditions in Egypt. Ten buffalo dams were available for the study. The animals were randomly divided into two groups. The first group was exposed to direct solar radiation, while the second group was under shade; Weekly measurements and blood samples were taken from (July to August) in the morning before feeding and watering. The results showed that the correlation coefficient between THI and with CCI Index under direct solar radiation in Egypt from July to August months was (0.84). The (THI) is still the best indicator of animal stress under environmental conditions in Egypt. The average daily milk decreased by 0.800 Kg and the average birth weight by 10 Kg and decreased of quality of colostrum this increased value of THI by 10. Its recommended buffalo animal of climatic change under any environmental conditions adapted and we can maintain milk and meat production from buffaloes with bad environmental conditions with climatic change.

Keywords: Solar Radiation, Physiological, Productive, Buffalo dams and Climatic change.

INTRODUCTION

Productive performance is the most important indicator among various indices of animals' adaptability to environmental conditions. Under hot environmental conditions, the productive and reproductive efficiency of farm animals is negatively affected. The negative effects of heat stress will become more apparent in the future if climate changes continued as most predicted and as the world's population increased IPCC (2021). The thermal environment has to store influence on farm animals with air temperature having a primary effect, but altered by wind, precipitation, humidity, and radiation. Moreover, high humidity seems to affect buffaloes less than cattle, since buffaloes may be superior to cattle in humid areas if shade or wallows are available (Omran *et. al.,* 2011 a, b, c, d and 2019 a) under artificial conditions in the lab under the environmental condition in Delta Nile and Omran and Fooda (2013). The thermal environment is a major factor that negatively affects milk production of dairy animals, especially in animals of high genetic merit. Omran and Fooda (2013) reported that any improvement in the temperature-humidity index (THI) around animals is reflected in all biological processes for animals.

Milk yield decreased by 0.41 kg per cow per day for each point increase in the THI values above 69 (Aggarwal 2006), while meat production decreased by 0.45 Kg/day when THI was 100. It is known that behavioral and physiological responses are initiated to increase heat loss and reduce heat production in an attempt to maintain body temperature within the range of normality. These responses may be responsible for the alteration of colostrum and milk production in terms of quantity and quality. Increased heat stress due to an increase in respiration rate (RR), rectal temperature (RT), and water intake, while feed intake, growth rate, mammary gland development, reproductive performance, and immunity status during the transition period were decreased (Omran *et al.,* 2020, 2013; Lacetera *et al.,* 2006). Additionally, maternal heat stress during late gestation also inhibits the immune responses of the Heat stress during late pregnancy affects not only the animal's performance but also its neonate. During the late pregnancy period, malnutrition is related to the decrease in the birth weight of offspring, increased incidence of dystocia, and high morbidity and mortality of newborn calves (Wu *et al.,* 2006). Offspring (Merlot *et al.,* 2008). The fetus is protected primarily by the immune system, but the phagocytic activity of its immune cells is not fully developed until late in gestation (Barrington, 2001).

The calf absorption of immunoglobulins during the first 48h after birth comes from colostrum. Shade for dairy cows is considered essential to minimize the loss in milk production and reproductive efficiency. It was estimated that the total heat load could be reduced by 30 to 50% with a well-designed shade (Collier *et al.,* 2006; Omran *et al.,* 2019 a and b). Under the environmental condition in Egypt, animal production decreased, as well as the numbers of buffaloes and cows when the country was exposed to heat and cold waves in years (2015, 2020, and 2022). The Egyptian buffalo is an important tropical animal adapted to the environmental and managerial conditions in Egypt. It is the main source of milk and meat production where it contributes about 40- 45% and 30-35 %, respectively and the population in Egypt is about 1.4 million head according to MALR, (2019). The buffalo is considered an eco-friendlier than cows since the adult buffalo animal produces 157 gm of methane per day while a cow produces 376 gm of methane per day, thus the buffalo animal is eco-friendlier than cows (Appuhamy *et al.,* 2016). And it's the main dairy animal raised by small farmers in Egypt. It's found in the humid tropics, and the suitability of the buffaloes to the hot climatic conditions is shown to be achieved by morphological, anatomical, and physiological characteristics (Shafie and Omran 2018).

Additionally, buffalo can change the morphological appearance of their skin to maintain bioprocesses and the size of the surface area of the animal's body and skin color exhibit special adaptation to environmental factors.

The great effect of direct solar radiation on sebum secretion in buffaloes, Friesians and other cattle breeds may be attributed to the black skin in the former two breeds. This greasy sebum layer melts during hot weather and thus becomes glossier to reflect much of the incident heat rays to relieve the animal from excessive external heat load. However, buffaloes showed a negative reaction to solar radiation by decreasing the sebum secretion while cattle bread showed a positive reaction (Shafie and Omran 2018). Omran and Fooda (2013) investigated the environmental condition in Middle Egypt and showed that buffalo calves were able to maintain a good performance and can cope with different stress factors when THI reached 91. Buffalo has a physical adaptation to tropical and subtropical hot humid conditions. In Egypt, the largest number of buffaloes for small farmers represents approximately (75%) of the total population. The main objective of this investigation was to study impacts of buffalo dams exposure (at late gestation) to heat stress induced by direct solar radiation on the physiological, haematological and productive performance. Also, to study the effect of heat stress on colostrum quality as an efficient source for passive immunity transfer for the offspring. In addition to the study of the Comprehensive Climate Index (CCI) under Egyptian conditions with the higher solar radiation that characterizes the Nile Valley in comparison with the temperature-humidity index (THI) that is still the proper indicator of animal stress under the environmental conditions in Egypt.

MATERIAL AND METHODS

The experimental work was carried out at Seds Experimental farm in Beni Suef Governorate, Animal Production Research Institute, Agriculture Research Center, Egypt.

1-Experimental animals and management:

Ten pregnant buffalo dames were randomly divided into two groups (five animals each). The average body weight was from (550-580 Kg) and the parity was from (4 and 5 lactation periods).

The experimental work commenced in July 2013 so that all pregnant animals were chosen during their late pregnancy period (2 months before calving). Animal's house was an open system; the roof was from cement its height was 2.70 meters and the floor was solid clay. Feeding and drinking were in basins of cement. The experimental animals were fed according to animal production research institute allowances (APRI, 1997), and water was available for animals during the experimental period.

2-Experimental design:

The first experimental group (group A) was exposed to direct solar radiation (without shading), and the second group (group B) was kept under cement shade covered by three layers of straw bales. Both groups were subjected to the experimental work for two months before calving.

The experimental work was conducted in two stages, in the first stage the animal respiration rate (RR, r/min) was measured and blood samples were collected, the second stage after calving included recording of calf birth weight, daily milk (DM, / Kg), total milk yield (TMY/kg), lactation period (Lp /day) and calving interval (Cl/month). Colostrum samples of the first three days post-parturition were individually collected followed by milk sampling for composition analysis.

Blood sampling:

Blood samples were collected via the jugular vein of each animal on weekly basis during the last two months of the pregnancy period (July to August) in the morning before feeding and watering in heparinized tubes from the external jugular vein. Fresh blood samples were used for determination of hematocrit (Ht %), neutrophils (Ne%) and lymphocites (Ly%) while, samples of blood plasma were used for determination of total protein (Tp, g/dl), Albumin (Alb, g/dl), Immunoglobulin (IgG, mg/dl). and the thyroid hormones: (Triiodothyronine hormone (T3, ng/dl) and Thyroxine (T4, µg/dl).

Meteorological data:
The meteorological data included air temperature (AT, °C) relative humidity (RH, %,) Wind speed (WS, Km/hr.), and solar radiation (RAD MJ/m^2/day) were weekly recorded to calculate the temperature-humidity index (THI) and Comprehensive Climate Index (CCI) around the animals. The calculation of (CCI) by using equitation Mader et, al. (2010).

CCI=T+RHC+WSC+RADC

Where RHC, WSC, and RADC are the correction factors to RH, WS, and RAD, respectively. The correction factors are:

RHC = e^(0.00182×Rh+(1.8×⟦10⟧^(-5)))×[0.000054×T^2+0.00192×T-0.0246]×[Rh-30],

WSC = [(-6.56)/e^({[1/⟦(2.26×ws+0.23)⟧^(0.45)]×[2.9+1.14×⟦10⟧^(-6)×⟦ws⟧^(2.5)-log⁡⟦0.3⟧ ⟦(2.26×ws+0.33)⟧^2]})]-0.00566 ×⟦ws⟧^2+3.33,

RADC = 0.0076×RAD-0.00002×RAD×T+0.00005×T^2×√RAD+0.1×T-2

Where T is measured in Celsius, WS is measured in meters/second and is measured in global horizontal irradiance in watts/meter. The correction factors account for the impact that these weather variables have on animal comfort. For example, high humidity exacerbates high temperatures in animal discomfort; wind cools animal discomfort under high temperatures but heightens cold stress in times of low temperatures. Additionally, the solar radiation correction factors have a nearly linear relationship with temperatures.
The calculation of (THI) by using the equation of Mader et. al., (2006) was as follows;
THI = (0.8*T) + [(RH/100) * (T-14.4)] + 46.4
Where: air temperature (T, °C), and relative humidity (RH, %).

Statistical Analysis:
The data were analyzed by SAS (2002) using two statistical models, model 1 for both groups (A and B) whereas model 2 was assigned for group A only as follows:

Model1:

$Y_{ij}= \mu + G_i + b (H)_{ij} + (GH)_{ij} + E_{ij}$

Where: Yij: observation on the jth animals of the ith group, µ: Overall mean, Gj: fixed effect due to the group (1 = Under Shade, 2= Under direct solar radiation), b: regression coefficient of Y on H (THI); (GH)ij: the interaction between G and H and eij: random error assumed N.I.D. (0, $\sigma^2 e$).

Model2:

$Y_i = \mu + b1 (H)_i + b2 (C)_i +(HC)_i + E_i$

Where: Yi: observation on the ith animals, µ: Overall mean, b1: regression coefficient of Y on H (THI); b2: coefficient regression of Y on C (CCI), (HC)i: the interaction between H and C and Eij: random error assumed N.I.D. (0, $\sigma^2 e$).

The formula was Y = a + xb, where Y= The studied traits, a= intercept, x= THI or CCI and b the regression coefficient for Y on X, to estimate the equations for predicting the changes in the all studied traits with the expected changes in the indices THI and CCI for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during dry period.

RESULTS
Extreme weather conditions around buffalo dames for two groups before calving, In **Table (1).** It was found that air temperature (AT, °c) without shade was higher approximately by 10°c., while relative humidity (RH%) was higher under shade approximately by 12%., the value of the temperature-humidity index (THI) was higher without shade compared with that under shade by 12.6%. The value of the Comprehensive climate index (CCI) was 42.95, while THI value was 83.82 under direct solar radiation while under shade THI value was 73.24, the values of THI under direct solar radiation were classified as moderate heat stress while under shade was mild heat stress. The Index of CCI was 42.95 from July to August month these values may be considered as moderate heat stress under the prevailing environmental condition in Egypt, while the value of CCI being 40 from July to August in the United States was defined as severe heat stress. Results of the current study indicated that the correlation coefficient between THI index and CCI Index under direct solar radiation in Egypt during July to August months was (0.84).

Then the temperature-humidity index (THI) is still the best and simplest formula to assess animal stress (during hot or cold weather) and interpret physiological parameters with changing climates.

Table 1. (Mean ± SE) for air temperature, relative humidity, wind speed, solar radiation above animals (2 meters), temperature humidity index and comprehensive climate index.

Items	Under direct solar radiation (A)	Under Shade (B)
Air temperature (AT, °C)	37.01±0.13	26.53±0.19
Relative humidity (RH, %)	34.66±0.71	46.32±0.47
Wide speed (WS, h)	3.69±0.10	.
Solar radiation (RAD, MJ/m^2/day)	28.31±0.19	.
Temperature humidity Index (THI)	83.82±0.13	73.24±0.25
Comprehensive Climate Index (CCI)	42.95±0.12	.

Impact of heat stress on respiration rate and animal hematology:

Table (2) found higher significance between the two groups (A & B). Values of RR, r /min and neutrophil, % were higher in group (A) than in group (B), while values of hematocrit (Ht, %) and Lymphocyte (Ly, %) the values were lower in group (A) than group (B). The increase in RR with increasing temperature may be due to more demand for oxygen by the tissues in stressful conditions and the drop of Ht (%) may be due to a reduction in oxidation activity and metabolism.

Table 2. (Mean ± SE) for respiration rate, hematocrit, percentages of leukocyte types neutrophil and lymphocyte for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during a dry period.

Items	Under direct solar radiation (A)	Under Shade (B)
Respiration rate (RR, r/min)	35.63±0.10^a	25.64±0.67^b
Hematocrit (Ht, %)	34.27±0.19^b	39.34±0.14^a
Neutrophils (Ne%)	53.35±0.20^a	34.34±0.10^b
Lymphocyte (Ly%)	38.39±0.22^b	57.10±0.63^a

Mean values for each item with different superscripts in the same raws are significantly different (P ≤ 0.05).

The immunological reaction was fortified by an increase in Ne against a decrease in Ly. An increase in values of THI by 12.6% resulted in an increase in RR and Ne by percentages 28% and 35.6%, and the decrease of Ht and Ly by 13% and 32.8%, respectively. Fig (1 to 4) shows changes in RR as well as blood haematology Ht% and Ne% to Ly %weekly during the dry to birthday period (last 8 week) for the two groups.

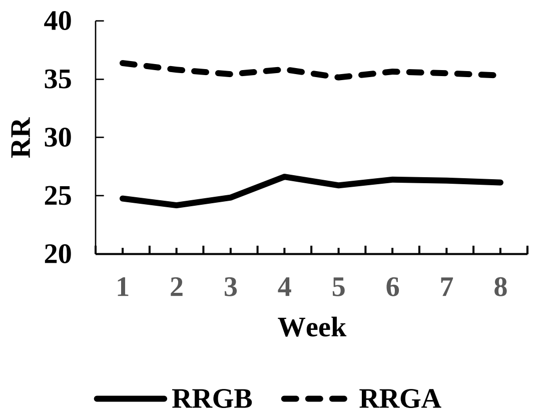

Fig.(1). Physiological responses (respiration rate (RR, rmin) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

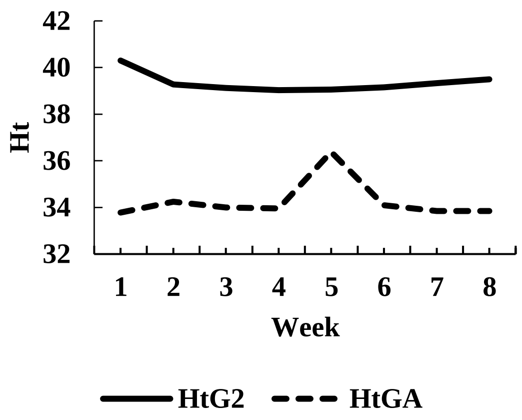

Fig.(2). Hematological responses (heamatocrit, Ht, %) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

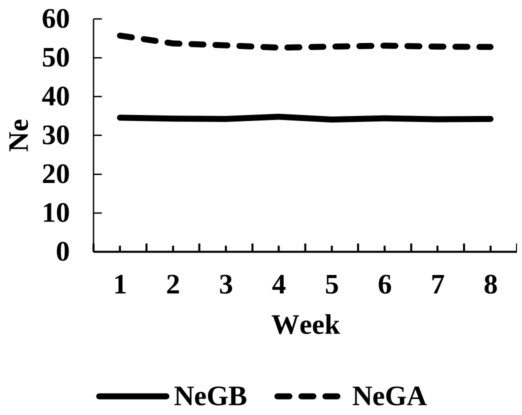

Fig.(3). Hematological responses (Neutrophils, Ne, %) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

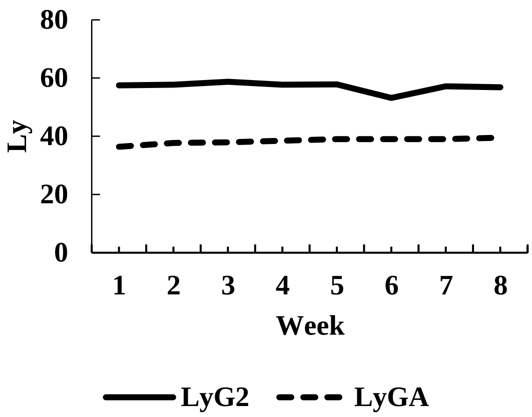

Fig.(4). Hematological responses (Lymphocyte, Ly, %) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

Fig (1) RR r/min the first physiological reaction to stress was a significant increase for the value in the first week from exposure to stress (group A) and stability until four weeks increased in two groups (A & B) in the fifth week and stable until calving. It has been proved by several studies that buffaloes have a low capability of sweating thus it depends on an increased rate of respiration to insure enough water vaporization for proper heat dissipation, RR thermoregulatory mechanism, the stability of RR r/min under these conditions indicators to the buffalo animal can express heat tolerance over.

Fig (2) haematological reaction: the first Ht % significantly decreased in the first week due to heat shock by exposure to direct solar radiation, and the significant increase occurs in the fifth week may be to increased oxidation activity and metabolism added to increase drinking water to need the prepare the colostrum and the new milk season.

Fig (3 & 4) the second Ne% and Ly %, in general, to maintain the percentage (LCT %) increase Ne under stress decreased in Ly.

In group (A) a significant increase in Ne% in the first week is offset by a significant decrease in Ly stability until the fifth week is a slight increase stabile until calving.

In group (B), the situation is normal, with a percentage in the sixth week significant decrease in Ly and a gradual return to placement until calving. This result indication of immunological activity and the following is an indicator of the performance of buffaloes under this lode.

Changes in blood proteins and immunogobulins (Ig G):

Table (3) show higher significance between the two groups, the values of TP, Alb, Glb, and IgG, were lower in group (A) than in group (B). The increased values of THI by 12.6% caused a decrease in the TP, Alb, Glb, and IgG by 18.5, 11.5, 23.5, and 16, 3%, respectively. Plasma proteins, particularly albumin concentration usually decreased under heat stress nearly by 10 %.

Table 3. (Mean ± SE) for total protein, albumin, globulin and immunoglobulin for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during dry period.

Items	Under direct solar radiation (A)	Under Shade (B)
Total protein (TP, g/dl)	8.04±0.04^{b}	9.87±0.02^{a}
Albumin (Alb, g/dl)	3.74±0.04^{b}	4.23±0.03^{a}
Globulin (Glb, g/dl)	4.30±0.04^{b}	5.62±0.03^{a}
Immunoglobulin (IgG, mg/dl)	515.70±0.62^{b}	616.45±0.55^{a}

Mean values for each item with different superscripts in the same raw are significantly different (P ≤ 0.05).

The significant decline in plasma protein leads to decreased protein synthesis in addition to decreased nitrogenous nutrients and mineral intake which occurs under heat stress conditions. This is evident in Table (7) where the average birth weight of calves in group (A) was lower than the calves in the group (B) with a difference of 10 Kg. and as seen percentage of protein in colostrum in the group (A) was lowered than that in group (B) by 4.56%. Fig (5 to 8) shows changes in blood plasma components TP, Alb, Glb and immunogobulins IgG weekly during the dry to birth day period (last 8 week) for two groups.

Blood plasma components: Fig (5) show that, in group (A) the TP, g/dl was decreased from the first week and decreased gradually until the third week will be a significant decrease, followed by an increase in the fourth week fixed until calving. Fig (6) show that, the Alb, g/dl decreases from the second week and gradually decreases, the significant decrease was in the third week, it started to improve from the fourth week with an increase but it is still less than the group (B).

Fig (7) show that the Glb, g/dl was significant decreases in the first week, followed by an increase in the fifth week fixed until calving.

Fig (8) shows, the IgG, mg/dl was a significant decrease in the first week, followed by a slight increase in the fifth week and still to the same point until calving. While group (B) slightly decreased in the seventh week fixed until calving.

Alb was a slight increase in the third week, followed by a slight decrease until the fifth week and stile to the same increase until calving. Glb was fixed and decreased in the seventh week until calving. IgG, a slight stable increase in the fifth week followed by a slight stable decrease until calving.TP lowers the energy from the body to decrease the feed intake.

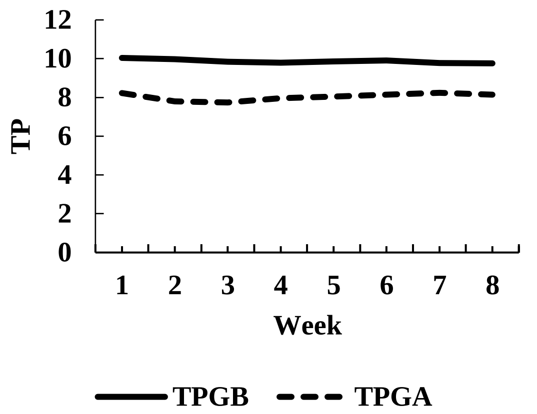

Fig.(5). Total protein (TP, g/dl) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

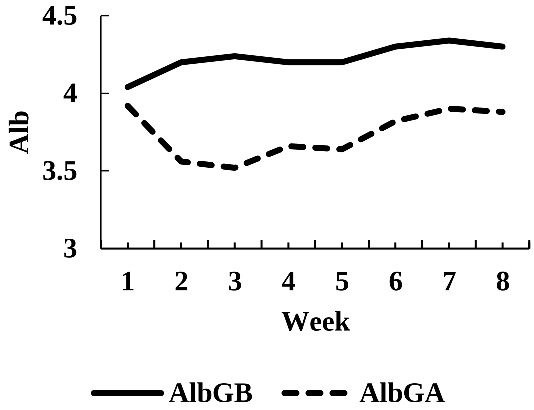

Fig.(6). Albumin (Alb, g/dl) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

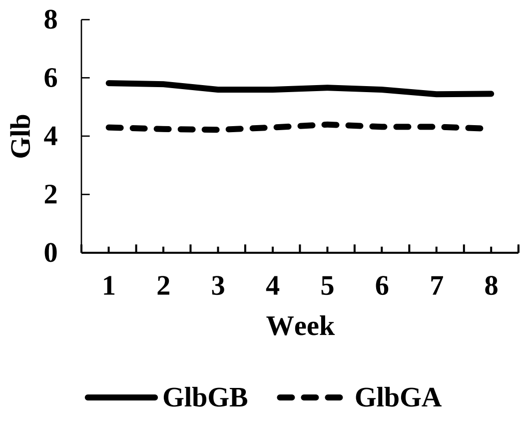

Fig.(7). Globulin (Glb, g/dl) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

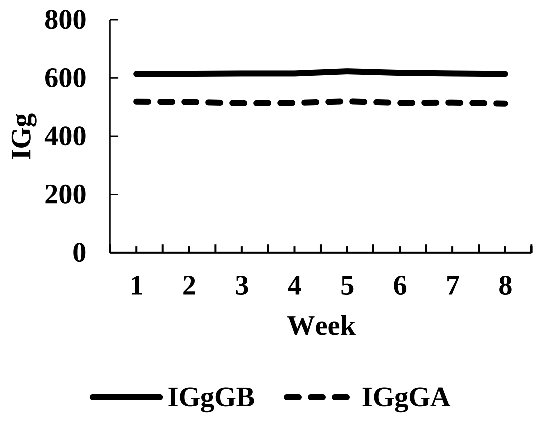

Fig.(8). Immunoglobulin (IgG, mg/dl) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

Changes in thyroid hormones:

Thyroid hormones, either thyroxine (T4) or triiodothyronine (T3) are known to play an important role in the animal's adaptation to environmental changes. Added to its role in growth regulation and are essential for the maintenance of the basal metabolic rate. Results in Table (4) indicated higher significant differences between A and B groups, the values in group (A) were lower than in group (B) for T3 and T4. The increase of THI values by 12.6 % for group A decreased vT3 and T4 concentrations by 44% and 34.9%, respectively. Concentrations of the thyroid hormones in response to heat stress are slow and may take several days to weeks.

Table 4. (Mean ± SE) for thyroid hormones for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during dry period.

Items	Under direct solar radiation (A)	Under Shade (B)
Triiodothyronine (T_3, ng/dl)	127.32 ± 0.86^{b}	$227.80.\pm3.54^{a}$
Thyroxine (T_4, µg/dl)	10.97 ± 0.16^{b}	16.85 ± 0.10^{a}

Mean values for each item with different superscripts in the same raw are significantly different (P ≤ 0.05).

Fig (9 &10) show the changes in blood plasma hormones (T3, ng/dl, and T4, µg/dl) weekly during the dry to birthday period (last 8 weeks) for two groups.

In group (A) was T3, a significant decrease in the first week, followed by a slight increase in the fifth week still until the seventh week and a decrease until calving, T4 was increased in the first week and decreased significantly decrease in the fourth and fifth week and return the increase of the week sixth and seventh and eight week decreases until calving. In group (B)T3 was a significant decrease in the sixth week, followed by a gradual increase in the seventh week of gradual decrease until calving.

T4 gradual increase in the fourth week was significant in the fifth week decreasing gradually from the sixth week to the seventh and decreasing until calving.

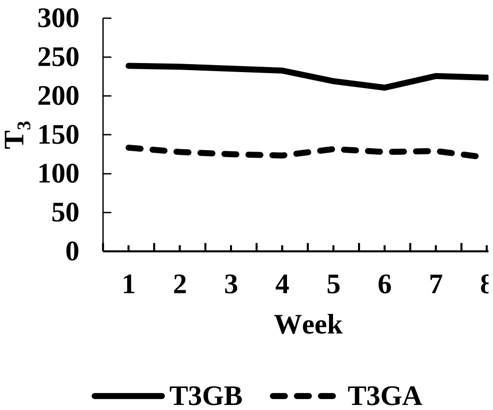

Fig.(9). Triiodothyronine (T_3, ng/dl) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

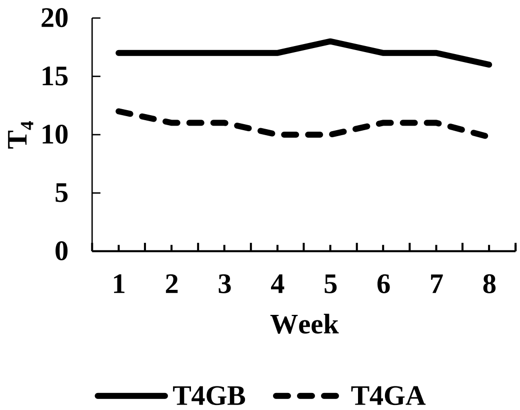

Fig.(10). Thyroxine (T_4, µg/dl) for buffalo dams exposure to direct solar radiation (A) and buffalo dams under shade (B) during eight weeks before calving.

Changes in animal performance:

As shown in Table (5) estimates of total milk yield (TMY), daily milk yield (DM), lactation period and calf birth weight were significantly (P <0.05) lower in group A than group B. It is worth mentioning that values of average birth weight of calves and total milk yield in the group (A) came from four dams only since one of the five dams had an abortion without milking. The increase of THI value (from 73.24 to 83.82) or by 12.6% under severe thermal stress (group A) decreased the TMY, DM, LP/day and ABW by 35.8 %, 11.8 %, 27.4 % and 24.0 %, respectively. The average daily milk was less in group (A) compared with a group (B) by 0.800 /g/day, and the average birth weight was less than 10 kg with an increase of THI by about ten units., With hot thermal conditions reduction of feed, intake leads to a reduction in the metabolic heat production associated impaired with digestive and metabolic processes.

Table 5. (Mean ± SE) for total milk yield, Lactation period. Daily milk and calving interval for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during dry period.

Items	solar Under direct radiation (A)	Under shade (B)
Total milk yield (TMY, kg)	1093 ± 71.60^{b}	1703.5 ± 74.54^{a}
Lactation period (LP, day)	182.7 ± 23.55^{b}	251.6 ± 4.23^{a}
Daily milk (DM, kg)	6.0 ± 0.23^{b}	6.8 ± 0.26^{a}
Calving interval (CI, month)	13.43 ± 0.00^{a}	11.83 ± 1.50^{a}
Average birth weight calves (Kg)	31.6 ± 0.23^{b}	41.6 ± 1.50^{a}

Mean values for each item with different superscripts in the raw column are significantly different (P ≤ 0.05).

Predicting equations for changes in studied parameters:

Tables (6, 7, and 8) present the equations used for predicting the change in adaptive physiological, Hematological, blood plasma components, and blood plasma hormones with the expected changes in THI, CCI under direct solar radiation, and THI under shade for buffalo dams during the dry period.

Table 6. Equations for predicting the changes in respiration rate and haematological response with the expected changes in the indices THI and CCI for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during dry period.

Under direct solar radiation (A)		Under Shade (B)
THI	CCI	THI
$RR = 50.18 + (-0.17) (THI)^{ns}$	$RR = 51.72 + (-0.37) (CCI)^{***}$	$RR = 31.28 + (-0.08) (THI)ns$
$Ht = 44.79 + (-0.13) (THI)^{ns}$	$Ht = 19.63 + 0.34 (CCI)^{ns}$	$Ht = 40.00 + (-0.01) (THI)^{ns}$
$Ne = 69.42 + (-0.19) (THI)^{ns}$	$Ne = 81.22 + (-0.65) (CCI)^{***}$	$Ne = 44.37 + (-0.14) (THI)^{*}$
$Ly = 17.04 + 0.25 (THI)^{ns}$	$Ly = 3.92 + 0.80 (CCI)^{*}$	$Ly = 65.17 + (-0.11) (THI)^{ns}$

* : $P \leq 0.05$ ** : $P \leq 0.01$ *** : $P \leq 0.001$ ns : Not significant ($P \geq 0.05$)

Table 7. Equations for predicting the changes in total protein (TP), albumin (Alb), globulin (Glb) and immunoglobulin (IgG) with the expected changes in temperature humidity index (THI) for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during dry period.

Under direct solar radiation (A)		Under Shade (B)
THI	CCI	THI
$TP = 11.52 + (-0.02) (THI)^{ns}$	$TP = 12.18 + (-0.05) (CCI)^{***}$	$TP = 6.57 + 0.02 (THI)^{ns}$
$Alb = -0.10 + 0.05 (THI)^{ns}$	$Alb = 0.69 + 0.08 (CCI)^{*}$	$Alb = 3.08 + 0.01 (THI)^{ns}$
$Glb = 9.51 + (-0.05) (THI)^{ns}$	$Glb = 9.37 + (-0.09) (CCI)^{*}$	$Glb = 3.54 + 0.01 (THI)^{ns}$
$IgG = 675.77 + (-0.71) (THI)^{ns}$	$IgG = 570.98 + 1.06 (CCI)^{ns}$	$IgG = 483.99 + 0.43 (THI)^{ns}$

* : $P \leq 0.05$ ** : $P \leq 0.01$ *** : $P \leq 0.001$ ns : Not significant ($P \geq 0.05$)

Table 8. The equation for predicting the changes in thyroid hormones with the expected changes in temperature humidity index (THI) for buffalo dams exposure to direct solar radiation (Group A) and buffalo dams under shade (Group B) during a dry period.

Under direct solar radiation (A)		Under Shade (B)
THI	CCI	THI
$T_3 = 142.90 + 1.01 (THI)^{ns}$	$T_3 = 419.94 + (-4.47) (CCI)^{ns}$	$T_3 = 67.23 + 0.82 (THI)^{ns}$
$T_4 = 17.98 + (-0.01) (THI)^{ns}$	$T_4 = 10.99 + 0.14 (CCI)^{ns}$	$T_4 = -4.10 + 0.21 (THI)^{*}$

* : $P \leq 0.05$ ** : $P \leq 0.01$ *** : $P \leq 0.001$ ns : Not significant ($P \geq 0.05$)

Changes in colostrums and milk composition:

Display the colostrum component concentration for two groups of buffalo dams exposed to solar radiation and under-shaded during the first three days after birth. In Table (9), the values were significantly ($P < 0.05$) lower in the group (A) than in group (B)., The increased values of THI by 12.6% decreased the content of the colostrum as lactose, protein, total solids, fat and Ash by 66.8 %, 52.3 %,49.2%, 46.6%, and 7.1%, respectively. This result reflects the negative impact of heat stress at late period of pregnancy on the quality of the produced sediment, which leads to a decrease in the immunity of the suckling calves and a great chance of increased mortality as well as impairment of the dam potentiality during post parturition period.

Table 9. Colostrum component concentration for two groups of buffalo dams (exposed to solar radiation (Group A) and under shaded (Group B)) during the first three days after birth.

Items	Under direct solar radiation (A)	Under Shade (B)
protein %	6.9±0.15^{b}	14.46±0.089^{a}
Fat%	5.12±0.08^{b}	9.59±0.07^{a}
Lactose%	0.6 4±0.04^{b}	1.93±0.34^{a}
Total solids%	12.66 ±0.24^{b}	24.92 ±0.28^{a}
Ash %	0.99 ±0.24^{a}	1.06±0.03^{a}

Mean values for each item with different superscripts in the same raw are significantly different (P ≤ 0.05).

Table (10) The decrease in yield and constituents of milk of dairy cattle as a result of exposure to high environmental temperature might be due to the decline in protein, carbohydrate, lipid mineral, and vitamin metabolism which leads to a negative balance in nitrogen, energy, and minerals resulting in low protein turnover, less heat production and fewer minerals for the biosynthesis of milk.

Table 10. Milk components concentration for two groups of buffalo dams (exposed to solar radiation (Group A) and under shade (Group B)) after calving.

Items	Under direct solar radiation (A)	Under Shade (B)
protein %	3.32 ± 0.02^{a}	4.36± 0.07^{a}
Fat%	5.2 ±0.01^{a}	6.9±0.07^{a}
Lactose%	4.35±0.11^{a}	5.26±0.05^{a}
Total solids%	15.01±0.11^{a}	17.37±0.16^{a}
Ash %	0.95±02^{a}	0.93±0.03^{a}

Mean values for each item with different superscripts in the same raw are significantly different (P ≤ 0.05).

Present the milk components concentration for two groups of buffalo dams exposed to solar radiation and under-shaded after calving. No significant differences were detected between the two groups. However, the values were lower in group (A) than in group (B) except for Ash.

The increased value of THI by 12.6% decreased the percentage of the components of milk as fat, protein, lactose, total solids, and Ash by 24.5%,23.5%, 17.3% and 13.6% while Ash increased by 2.1%.

DISCUSSION

The temperature-humidity index (THI) is a single value depicting the integrated effects of air temperature and humidity associated with the level of heat stress. This index has been developed as a weather safety index to control and decrease heat stress-related losses (Bohmanova *et al.,* 2007, Omran and Fooda 2013, Omran *et al.,* 2019 a, b, c and 2020). The THI is a practical and useful tool for many applications in animal biometeorology. THI is extensively used in hot regions all over the world to evaluate the effect of heat stress on dairy cows and used to estimate the cooling necessities of dairy cattle to improve the efficiency of management strategies to alleviate the negative effects of heat stress (Ghavi *et al.,* 2013) Omran *et al.,* (2019b and 2020) Under environmental conditions in Nile valley Governorates reported mild heat stress when values of THI were 71.28 and moderate heat stress values of 84.38. Omran and Fooda (2013) under the condition of Nile valley (Beni Suef Governorate) reported that THI is a common indicator of the degree of climatic stress on animals where THI of (Thermo neutral ≤ 68, mild Heat stress < 74, moderate Heat stress < 82, sever Heat stress ≤ 87., the THI > 87 could be considered dangerous for Frisian calves, while this threshold was at THI > 91 for buffalo calves ., and the best THI for production in both types is lower than THI 68 but buffalo calve starts to be under cold stress at this threshold. Added to that any improvement in the index THI will ideally be useful as a base for the continued development of biological functions and consequences resulting from primary factors influencing energy exchange between the animal and its surroundings. Du Preez (2000) concluded that the THI index is still the best, simplest, and most practical index for measuring environmental warmth which causes heat stress in dairy cattle and physiological parameters must always be used together with THI values to determine and evaluate heat stress in dairy cattle.

In addition, THI offers a method of combining the more important and easily measured weather factors into a possible measure to compare temperature and humidity data and animal response at different climatic zones and locations. Mader *et al.,* (2010) reported that values of CCI are the first index that accounts for animal stress caused by both hot and cold weather in the feedlot as well as interactions between ambient temperature humidity, wind speed, and solar radiation. In addition, stress thresholds were developed to accompany the CCI to translate index values to weather-related stress in fed cattle. Using this newly developed index, we can relate weather-based animal stress to profitability to estimate the impact of extreme weather on cattle feeding profits. Under environmental conditions in Egypt, three regions of climatic conditions were defined (Lower, Middle, and Upper Egypt) Omran *et al.,* (2020) reported that the highest values of THI were found in August in the three regions whereas, the lowest values of THI were found in February at the same regions. The authors suggested the equations used for predicting the changes in adaptive physiology and haematology with the expected changes in THI for buffaloes and cows. Under Egyptian conditions, THI can be adopted even under direct solar radiation since it gives the same expected results and the evidence is not a strong positive correlation coefficient. The predictive equations in **Tables (6, 7and 8)** cleared that the two indicators (THI and CCI) are very close to each other.

Impact of heat stress on respiration rate and animal haematology:

Respiration rate (RR, r/min) is a good measure to detect the response of an animal to variation in the microenvironment around the animal, thus giving clear evidence of the better capacity of heat tolerance. While the hematological parameters represent a fine mirror that reflects healthy conditions of the animal and adapting to the surrounding environment. Under heat stress, the animal behavioral and physiological responses are initiated to increase heat loss and reduce heat production in an attempt to maintain body temperature within the range of normality (38.3-38.7°c). Joshi and Tripathy (1991) recorded a 2.6°c rise in rectal temperature in buffaloes when exposed to direct sun rays in June and July. Omran *et al.* (2020) reported that values of RR were faster indicators of any changes in the microenvironment around animals when compared with the slow alterations in skin temperature (ST °C), Adding that Ht% is a sensitive indicator to the surrounding thermal conditions when compared with hemoglobin concentrations. Therefore, RR and Ht% can be used as a good and faster indicators of animal stress. Omran et, al. (2011a) under artificial constant severe heat stress reported that responses of five leukocyte cell types (LCT%) were negatively altered by the magnitude changes that occurred in the percentage of Lymphocytes (Ly%) and monocytes (Mo %) decrease while Neutrophils (Ne%) and eosinophils (Eo%) increased then increased in Ne% decreased in Ly% and as seam the trend under natural environmental conditions. Omran (1999) reported that the average values in Buffalo calves for Ne% and Ly% were (58.3 % LY) and (34.1%Ne) in winter compared to that in summer values were (56.98 % Ne) and (35.4 % LY) thus the increased values of (Ne%) and (Eo%) were indicator to heat stress of animals. Mitlohner *et al.,* (2002) reported that Ne% under shade was decreased as compared with that without shading adding that heat exposure before parturition caused increased neutrophils, phagocytosis and oxidative burst after animals were returned to a thermoneutral environment post-calving. Strong *et al.* (2015) reported that under heat stress greater percentage of Ne and a lesser Ly percentage were noticed compared with calving under comfort conditions. Reber *et al.,* (2008) reported that the maternal leukocytes in colostrum play important roles in the establishment of the innate and adaptive immune system of neonatal calves.

Changes in blood proteins and immunogobulins (Ig G):

The plasma protein provides an efficient way of transferring the heat from inside the body to the outer surface of the skin for heat dissipation by non-evaporative processes during heat stress since it holds an adequate percentage of water in the intravascular fluids and maintains the viscosity of blood. Omran *et al.,* (2013) under artificial constant severe heat stress noticed a decreased total protein and albumin while increased Glb in response to elevated temperature when an animal was trying to counteract the negative effects of heat stress. A similar finding was obtained by Ganaie *et al.,* (2013) under environmental conditions. Lacetera *et al.,* (2005) reported that the effects of high environmental temperature on the immune response depending on the specific immune function under consideration and that neuroendocrine changes due to higher temperature may play a role in the perturbation of the immune functions. Monteiro *et al.* (2016) reported that it is the calf's lack of passive transfer that is responsible for fewer IgG concentrations rather than the colostrum quality, and the calves had an adequate passive transfer, regardless of the heat stress. Changes in thyroid hormones: West *et al.,* (2003) reported that metabolic heat production, and decreased thyroid hormones level during heat stress is an adaptive responses and also might be an attempt to reduce metabolic rate and heat production. The birth weight of calves in group (A) reflected the disturbance in metabolic rate as shown in table (5) and the additional reduction in plasma protein of dams (Table 3). Omran *et al.,* (2011) under artificial constant severe heat stress reported that T3 and T4 concentrations were decreased by more than 50% in response to heat stress, and the decrease in thyroid hormones was due to the decline in basal metabolic rate and muscle activity

to reduce heat production. Also, Omran *et al.* (2013) reported that T3, T4 and insulin are indicators of metabolic changes resulting from changes in feed intake due to changes in ambient temperature and humidity. The metabolic heat production, and decreased thyroid hormones level during heat stress is an adaptive response and also might be an attempt to reduce metabolic rate heat production West *et al.,* (2003). Changes in blood thyroid hormone concentration are an indirect measure of the changes in thyroid gland activity. A major exogenous regulator of thyroid gland activity is the environmental temperature (Dickson, 1993) when animals are exposed to stress for a long duration (chronic stress), they try to acclimatize to the adverse condition. Acclimation involves phenotypic responses to environmental changes, which are reflected in hormonal signals and also in alterations in target tissue responsiveness to hormonal stimuli. The time required for acclimation varies according to tissue types, and from a few days to several weeks, for example, changes in metabolism in response to heat stress occur over a few days Collier *et al.* (2008). Alteration in physiological responses to thermal stress was found to be within 24-48 h in Egyptian buffaloes to allow acclimatization of the animal against severe conditions under the artificial condition in the lab at (40°C) Omran (2008). The time from late pregnancy to early lactation is known as a transition period, and it is recognized as the period between 3week before and 3 weeks after parturition., During this period, physical, behavioral, metabolic, and hormonal changes are due to a decline in productive and reproductive performance (Contreras and Sordillo, 2011). Adaptation of the endocrine system during the transition period, primarily the thyroid gland, is the key factor in maintaining metabolic balance. All changes in the parameters under study give an indicator of the pace change in the efficiency of buffaloes to keep their life, and also prompt return to stability a maintain production.
Changes in animal performance:

Animal growth, milk production, and reproduction are impaired as a result of the drastic changes in biological functions caused by heat stress. Spiers *et al.,* (2004) reported that milk production declines as THI increases. Bouraoui *et al.,* (2002) reported that THI was negatively correlated to milk yield on daily basis. The increase in THI from 68 to 78 decreased milk production by 21% and dry matter intake by 9.6%. do Amaral *et al.,* (2010) reported that exposure to heat stress during dry period decreased milk production in the subsequent lactation and compromised immune function in the transition period. We can say TMY decreased for the group (A) than group (B) by 610.5 Kg during the season, the decrease of LP by 68.9 days, increased CI by 2 months, and decreased of ABW by 10 Kg. The buffalo, under direct solar radiation in the last period of pregnancy, was able to maintain its physiological function including milk production and reproduction, i.e., the animal combat stress under direct solar radiation and stress referring to critical stage (fetus and subsequent milk season) due to buffaloes recovery faster from heat stress Omran *et al.,* (2011b). Behavioral and physiological responses are initiated to increase heat loss and reduce heat production which could be considered an attempt to maintain body temperature within the range of normality. Predicting equations for changes in studied parameters: with severe climatic changes, productive disorders arise due to increased heat stress including decreased milk yield, reduced meat production, growth rate, and reproduction. estimation of the thi index for any region is helpful to predict the physiological, hematological, blood component, and hormone changes of the breed so that an appropriate animal can be chosen for breeding in the assigned region where it can express its genetic potential in the suitable environment for optimum production., using the predictive equations can enable the animal holder to make any modification to maintain the productivity of the animal. Khalil and Omran (2018) reported a significant change in the THI values during the period from 2046 to 2060 the classifications of THI during the study period found that the moderate class showed a significant gradual increase with time in all studied governorates where its record highest percentage in the last studied period (2046 – 2060), while the none sever class tends to decrease in all governorates on the account of increasing the mild and moderate classes.

Changes in colostrums and milk composition:

Zimbelman *et al.,* (2009) reported that high temperatures during late pregnancy and the early postpartum period markedly modify colostrum composition in addition to lowering the net energy for colostrum net energy due to a reduction in lactose, fat, and protein content. Bryant *et al.,* (2007) reported that hot conditions were associated with a reduction in milk and milk solids yield, fat and protein concentrations in all breeds. The authors suggested that the predicted declines in milk yield for any region would occur unless adequate environmental modifications were in place. Omran and Fooda (2013) reported that any improvement in THI is leading to an improvement in production.

CONCLUSION

The Correlation coefficient between THI and with CCI Index under direct solar radiation in Egypt from July to August months was (0.84), The Temperature humidity index (THI) is considered the best indicator of animal stress under environmental conditions in Egypt, The stability of respiration rate RR under these conditions indicates to the buffalo animal can express heat tolerance over. The increase in the THI% value has a greater effect on the haematological responses compared to the physiological response. May it can be said that heat-stressed by exposure to direct solar radiation leads to abortion by 20%. The average daily milk and the average birth weight decreased by 0.800 g/day and 10 Kg, respectively with an increase of THI by 10. Using the predictive equations may enable the animal holder to make any modification to maintain the productivity of the animal, the buffalo is an animal that can tolerant the bad conditions in micro-environmental conditions, even at this critical stage and it is waiting for the season of milk and new calve. It is recommended that buffaloes subjected to climatic changes under any environmental conditions adapted and should have taken care in this critical period, with suitable shading, and shading water basin to prevent direct solar radiation. We can maintain milk and meat production from buffaloes by avoiding bad environmental conditions and severe climatic changes.

REFERENCES

Aggarwal, A. (2006). Effects of environmental on hormones, blood metabolites, milk production & composition under two sets of management in cows & buffaloes. PhD thesis submitted to National Dairy Research Institute, karnal (Haryana), India.

Appuhamy, J. A., France, J., & Kebreab, E. (2016). Models for predicting enteric methane emissions from dairy cows in North America, Europe, and Australia and New Zealand. *Global Change Biology*, 22(9), 3039-3056.

APRI, (1997). Animal Production Research Institute allowances, Ministry of Agriculture, Dokki, Giza, Egypt.

Barrington, G.M.; Mcfadden, T. B.; Huyler,M. T. & Besser, T. E.(2001). Regulation of colostrogenesis in cattle. Livest. *Natural Product Sciences*, 70:95-104.

Bohmanova, J., Misztal, I., & Cole, J. B. (2007). Temperature-humidity indices as indicators of milk production losses due to heat stress. *Journal of Dairy Science*, 90(4), 1947-1956.

Bouraoui, R., Lahmar, M., Majdoub, A., & Belyea, R. (2002). The relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. *Animal Research,* 51(6), 479-491.

Bryant, J. R., López-Villalobos, N., Pryce, J. E., Holmes, C. W., & Johnson, D. L. (2007). Quantifying the effect of thermal environment on production traits in three breeds of dairy cattle in New Zealand. *New Zealand Journal of Agricultural Research*, 50(3), 327-338.

Collier, R. J., Dahl, G. E., & VanBaale, M. J. (2006). Major advances associated with environmental effects on dairy cattle. *Journal of Dairy Science,* 89(4), 1244-1253.

Collier, R. J., Collier, J. L., Rhoads, R. P., & Baumgard, L. H. (2008). Invited review: genes involved in the bovine heat stress response. *Journal of Dairy Science*, 91(2), 445-454.

Contreras, G. A., & Sordillo, L. M. (2011). Lipid mobilization and inflammatory responses during the transition period of dairy cows. *Comparative Immunology, Microbiology and Infectious Diseases,* 34(3), 281-289.

Do Amaral, B.C., E. E. Connor, S. Tao, M. J. Hayen, J. W. Bubolz, & G.E.Dahl.(2010).Heat stress abatement during the dry period influences prolacting signaling in lymphocytes. *Domestic Animal Endocrinology*. 38:38-45.

Du Preez, J. H. (2000). Parameters for the determination & evaluation of heat stress in dairy cattle in South Africa. Onderstepoort Journal of Veterinary Research, 67: 263-271.

Ganaie,A.H.;GauriShanker, Nazir A Bumlal,Ghasura R.S.;Mir,N.A.;wani,S.A. & Dudhatra,G.B.(2013).Biochemical & physiological changes during thermal stress in bovines. *Journal of Veterinary Science and Technology*, 4:126

Ghavi Hossein-Zadeh, N., Mohit, A., & Azad, N. (2013). Effect of temperature-humidity index on productive and reproductive performances of Iranian Holstein cows. Iranian Journal of Veterinary Research, 14(2), 106-112.

Hahn, G. L. (1981). Housing & management to reduce climatic impacts on livestock. *Journal of Animal Science,* 52(1), 175-186.

IPCC (2021). Intergovernmental Panel on Climate Change. http://www.ipcc.ch/report/ar5/wg1/.

Joshi,B.C. & Tripathy, K.C.(1991).Heat stress effect on weight gain & related physiological responses of buffalo calves. *Journal of Veterinary Physiology and Allied Science*,10:43-48.

Khalil, A. A., & Omran, F. I. (2018). Impact of climate change on temperature humidity index values in Egypt. *Journal of. Science Engineering and Technology*, 4, 1.

Lacetera, N., Scalia, D., Bernabucci, U., Ronchi, B., Pirazzi, D., & Nardone, A. (2005). Lymphocyte functions in overconditioned cows around parturition. *Journal of Dairy Science*, 88(6), 2010-2016.

Lacetera, N., Bernabucci, U., Scalia, D., Basiricò, L., Morera, P., & Nardone, A. (2006). Heat stress elicits different responses in peripheral blood mononuclear cells from Brown Swiss and Holstein cows. *Journal of Dairy Science*, 89(12), 4606-4612.

Mader, T. L., L., J. Johnson, & J. B. Gaughan. A Comprehensive index for Assessing Environmental Stress in Animal. Journal of Animal Science 88(2010):2153-2165. Doi:10.2527/jas. 2009-2586.

Mader, T. L., Davis, M. S., & Brown-Brandl, T. (2006). Environmental factors influencing heat stress in feedlot cattle. *Journal of Animal Science,* 84(3), 712-719.

MALR. (2019). Statistics of livestock. The Ministry of Agriculture and Land Reclamation, Egypt.

Merlot, E., Couret, D., & Otten, W. (2008). Prenatal stress, fetal imprinting and immunity. Brain, behavior, and immunity, 22(1), 42-51.

Monteiro, A. P. A., Guo, J. R., Weng, X. S., Ahmed, B. M., Hayen, M. J., Dahl, G. E., ... & Tao, S. (2016). Effect of maternal heat stress during the dry period on growth and metabolism of calves. *Journal of Dairy Science*, 99(5), 3896-3907.

Omran, F. I. (1999). Physiological reaction & growth performance of buffaloes & Friesian calves to heat stress Doctoral dissertation. M. Sc. Thesis, Faculty of Agricultural, Cairo University, Giza, Egypt, P 147).

Omran, F. I. (2008). Impact of thermo-physiological reaction on growth performance of buffalo calves (Doctoral dissertation, Ph. D. Thesis, Faculty of Agricultural, Cairo University, Giza, Egypt, P 142).

Omran, F. I., Ashour, G., Youssef, M. M., & Shafie, M. M. (2011). Responses of hematology, blood metabolites, mineral ions and hormonal profile to heat stress for Egyptian buffalo-calves. *Egyptian Journal of Agricultural Research,* 89(3), 1129-1140.

Omran, F. I., Shafie, M. M., Ashour, G. H., Hassan, L. R., & Youssef, M. M. (2011). Physiological reaction and growth performance of buffalo and Friesian calves after recovery from heat stress. In Proceedings of the 4th Scientific Conference of Animal Wealth Research in the Middle East and North Africa, Foreign Agricultural Relations (FAR), Egypt, 3-5 October 2011 (pp. 78-94). Massive Conferences and Trade Fairs.

Omran, F. I., Ashour, G., Shafie, M. M., Youssef, M. M., & Ahmed, M. M. (2011). Effect Of Heat Stress On Body Composition Of Egyptian Buffalo-Calves. *Egyptian Journal of Agricultural Research*, 89(3), 1141-1149.

Omran, F. I., Ashour, G. H., Hassan, L. R., Shafie, M. M., & Youssef, M. M. (2011). Physiological responses and growth performance of buffalo and Friesian calves under chronic severe heat stress. In Proceedings of the 4th Scientific Conference of Animal Wealth Research in the Middle East and North Africa, Foreign Agricultural Relations (FAR), Egypt, 3-5 October 2011 (pp. 1-13). Massive Conferences and Trade Fairs.

Omran, F. I., & Fooda, T. A. (2013, November). Thermal discomfort index for buffalo and Friesian under Egyptian condition. In The 4Th Scientific Conference of Animal Production Research Institute (April), Cairo, Egypt (pp. 12-13).

Omran, F. I., Shafie, M. M., Ashour, G. H., Yousse, M. M., & Hassan, L. R. (2013). Response of buffalo calves exposed to first and second acute thermal shocks. *Egyptian Journal of Agricultural Research*, 91(3), 1113-1128.

Omran, F. I.; Sahar, Abd El-Rahim A. & T. A. Fooda (2019a). Physiological & productive performance of Egyptian buffaloes and cows under different housing systems and environmental condition in the North of Delta region. Proceeding of the 1st International Conference of Animal Production, September 10-14, 2019, Sharm El Sheikh City, Egypt (Proceeding of the 2nd International Conference of the Egyptian Association for Improving Egyptian Buffaloes, The 5th International Conference of Animal Production Research Institute". 20-34.

Omran, F. I., Mahmoud, S. A., & Fooda, T. A. (2019). Impact of housing patterns on physiological and production performance for egyptian buffaloes and cows in Nile Valley. *Journal of Animal and Poultry Production*, 10(4), 89-94.

Omran, Fayza I., T. A .Fooda, & M. O. Taqi (2019b).Water and feed consumption & body weight of Egyptian buffaloes and cows under different regional climatic conditions in Egypt. *Journal of Animal and Poultry Production*, 10(8), 261-269.

Omran, F. I., Mahmoud, S. A., & Fooda, T. A. (2019c). Impact of Housing Patterns on Physiological & Production Performance for Egyptian Buffaloes and Cows in Nile Valley. Journal of Animal and Poultry Production, 10(4), 89-94

Omran, Fayza. I., Khali, A. A., & Fooda, T. (2020). Physiological responses & hematological aspects of buffaloes and cows under different climatic conditions in egypt. *Egyptian Journal of Agricultural Research,* 98(1), 64-79.

Reber, A. J., Donovan, D. C., Gabbard, J., Galland, K., Aceves-Avila, M., Holbert, K. A., ... & Hurley, D. J. (2008). Transfer of maternal colostral leukocytes promotes development of the neonatal immune system: Part II. Effects on neonatal lymphocytes. *Veterinary Immunology and Immunopathology,* 123(3-4), 305-313.

OMRAN, F. E. (2018). Adaptivity of buffalo calves to differ thermal conditions. Egyptian Journal of Agricultural Research, 96(2), 703-714.

Spiers, D. E., Eichen, P. A., Leonard, M. J., Wax, L. E., Rottinghaus, G. E., Williams, J. E., & Colling, D. P. (2004). Benefit of dietary seaweed (*Ascophyllum nodosum*) extract in reducing heat strain and fescue toxicosis: A comparative evaluation. *Journal of Thermal Biology*, 29(7-8), 753-757.

Strong, R. A., Silva, E. B., Cheng, H. W., & Eicher, S. D. (2015). Acute brief heat stress in late gestation alters neonatal calf innate immune functions. *Journal of Dairy Science*, 98(11), 7771-7783.

Cary, N. C. (2002). Statical Analysis System Institute Inc. SAS user's guide.

Wu, G., Bazer, F. W., Wallace, J. M., & Spencer, T. E. (2006). Board-invited review: intrauterine growth retardation: implications for the animal sciences. Journal of animal science, 84(9), 2316-2337.

West, J. W. (2003). Effects of heat-stress on production in dairy cattle. *Journal of Dairy Science*, 86(6), 2131-2144.

Zimbelman, R. B., Rhoads, R. P., Rhoads, M. L., Duff, G. C., Baumgard, L. H., & Collier, R. J. (2009, February). A re-evaluation of the impact of temperature humidity index (THI) and black globe humidity index (BGHI) on milk production in high-producing dairy cows. In Proceedings of the Southwest Nutrition Conference (ed. RJ Collier) (pp. 158-169).
http://cals.arizona.edu/ans/swnmc/Proceedings/2009/14Collier-09.Pdf

فاعليه الاجهاد الحرارى المستمر على الآداء الفسيولوجى والإنتاجى لإناث الجاموس خلال فتره الجفاف تحت الظروف المناخيه فى وادى النيل

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اجريت الدراسه فى وادى النيل (محافظه بنى سويف) فى محطه سدس التجريبيه التابعه لمعهد بحوث الانتاج الحيوانى مركز البحوث الزراعيه. الهد ف الرئيسى للدراسه هو دراسه فاعليه تعرض اناث الجاموس العشار فى الفتره الاخيره للحمل لاشعه الشمس المباشره على الاداء الفسيولوجى والانتاجى وجوده السرسوب بالاضافه الى دراسه دليل المناخ الشامل (CCI) تحت الظروف المصريه وشده الاشعاع الشمسى المميز لوادى النيل مقارنة بدليل الحراره والرطوبه (THI) استخدم فى الدراسة عشر من اناث الجاموس العشار فى فتره الجفاف وتم تقسيم الحيوانات عشوائيا الى مجموعتين المجموعه الاولى معرضه للشمس المباشره (بدون مظله) والمجموعه الثانيه تحت مظله قبل الولاده بشهرين خلال شهرين (يوليو واغسطس). وكانت اهم النتائج أن معامل الارتباط بين دليل المناخ الشامل ودليل الحراره والرطوبه 0.84 وبالتلى يظل دليل الحراره والرطوبه هو الافضل لقياس الاجهاد الحرارى تحت الظروف المصريه.زياده قيم دليل الحراره والرطوبه بمقدار 10 أدى الى انخفاض متوسط انتاج اللبن اليومى بمقدار 0.800جرام , وخفض متوسط وزن الميلاد العجول المولودة بمقدار 10 كيلو جرام .وانخفاض جوده السرسوب بمنوعيه عاليه.ونوصى بان الجاموس حيوان التغيرات المناخيه وانه يتاقلم تحت اى ظروف بيئيه محيطه به. ونستطيع الحفاظ على انتاج اللبن واللحم من الجاموس على الرغم من الظروف السيئه المتوقعه مع التغيرات المناخيه.

الكلمات المفتاحية: الاشعاع الشمسي، الفسيولوجي، الانتاجي، أمهات الجاموس، التغيرات المناخية.