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PHYSIOLOGICAL RESPONSES AND HEMATOLOGICAL ASPECTS OF BUFFALOES AND COWS UNDER DIFFERENT CLIMATIC CONDITIONS IN EGYPT.

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ABSTRACT

The aimed of this study to evaluate the relationship between temperature humidity index (THI) and the changes in physiological responses and hematological aspects of buffaloes and cows under different climatic conditions in Egypt. The data used were collected from six Egyptian Governorates located in three different geographic regions (Lower, Middle and Upper Egypt) during the period from January (2010) to December (2015). Two Governorates from each region were visited to collect the data. In each Governorate, 25 farms randomly selected to represent small, medium and large farms, the measurements were taken from 20 animals divided into (10 buffaloes and 10 cows) in each farm. Each groups was divided into two groups (5calves less than year, 5 calves more than year)

The environmental conditions were recording air temperature (AT°C) and relative humidity (RH %) to calculate temperature humidity index (THI). The environmental regions based on THI values were classified into four classes (cold, thermal neutral, mild heat stress and moderate heat stress). During farm monitoring, hair temperature (HT°C), skin temperature (ST°C), rectal temperature (RT°C) and respiration rate (RR r/min) of animals were recorded. In addition, blood samples were collected for determining hemoglobin concentration (Hb g/100 ml) and hematocrit (Ht%).

The results indicated that, values of HT, ST, RT and RR were slightly higher in cows than in buffaloes among all studied regions. Higher estimates of HT and ST were observed for buffaloes and cows in Lower Egypt (LE) compared with those in Middle Egypt (ME). Both species showed increased HT and ST with elevated temperature in the different climates. Narrow changes in RT among the different seasons and regions were noticed. Values of RR for both species were the highest at LE followed by ME and UE.

It was observed that buffaloes have the potentiality to maintain stability of ST within the different climatic conditions. Despite, sensitivity of buffaloes to cold waves was noticeable, the physiological characteristics of buffaloes showed more suitability to hot conditions than cows.

Values of Ht% during winter were less than those recorded in other seasons regardless of age category or species. Meanwhile, with subsequent increase in the ambient temperatures Ht % values descended relatively in both species. Value of Ht were noticeably greater in both species of UE compared with LE. or ME.

The study revealed the ability of using RR and Ht in particular as predictive measures for animal acclimation based on THI values in each specific region so that livestock holder has the choice to select the appropriate breed for raising to get efficient productivity according to compatibility with his farm location.

Key wards: Climatic, regional, Physiological responses, Hematological aspects, temperature humidity index (THI).

INTRODUCTION

An environmental condition is a constraint on efficient livestock production systems. Evaluation of the constraint level is a difficult, but it is necessary task before selection of appropriate breeds and modification in management or environments can be made. The climate is a combination of elements that include temperature, humidity, rainfall, air movement, radiation, barometric pressure and ionization (Johonson, 1987). Buffaloes and cows are the main sources of milk and meat production for human consumption. Both species are raised under climatic condition trying to maintain their biological

activity. The conduction, convection and radiation are all dependent on the thermal gradient, thus as air temperature rises towards body temperature the thermal gradient reduces, heat dissipation is less effective and evaporative cooling start when ambient temperature become equal or above body temperature (Khalifa, 2003). Despite uncertainties in climate variability, Intergovernmental panel on climate change IPCC (2013) the Fifth Assessment Report identified the "likely range" of increase in global average surface temperature between 0.3°C and 4.8°C by reaching 2100.

Under hot and warm environments, productive and reproductive efficiency of farm animals are negatively affected. The negative effects of heat stress become more apparent. 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. High ambient temperature around animal is the major constraint on animal production (Marai *et. al.,* 2002, Omran and Fooda, 2013). Many investigators reported that Thermo-physiological responses, rectal temperature (RT, °C) and respiration rate (RR, r/min) are good measures to detect the response of animal to variation in microenvironment around the animal thus giving a clear evidence of better capacity of heat tolerance (Shafie and Marai, 1966, Shafie *et al.,* 1994, Ashour *et al.,* 2004, Omran and Fooda, 2013 and Omran *et al.,* 2013). Collier *et al.* (2006) reported that skin temperature is highly correlated with respiration rate. Also, hematological parameters represent fine mirror that reflect healthy condition of the animal.

(Marai and Habeeb, 2010) reported that the effect of heat stress is accompanied by high ambient humidity. In Egypt, there are different climatic regions based on geographical locations each of them has its natural characteristics and specific breeds of animals. In Egypt, buffaloes and cows are the main source of milk and meat production. The population of buffaloes is 3.7 Million head while cows are 4.0 Million head (FAOSTAT, 2017), this number is distributed among the different climatic regions. The total number in Lower Egypt is 1.33 million head buffaloes and 1.45 million head cows, in Middle Egypt the total number is 0.51 million head buffaloes and 0.45 head cows while in Upper Egypt the total number 0.51 head buffaloes and 0.48 head cows respectively, (EARI, 2017). Hahn *et al.* (2003) and Omran and Fooda (2013) reported that any improved animal index (temperature humidity index THI) will ideally be useful as a base for continued development of biologic response functions and representative of consequences resulting from primary factors influencing energy exchange between the animal and its surrounding. Buffington *et al.* (1981) presented the black globe-humidity index (BGH) as a way to incorporate the environmental factors into a single value as a means of quantifying effective heat stress. Du Preez (2000) reported that THI still the best, simplest and most effective parameter for measuring environmental warmth and physiological parameters must always be used together with THI values to determine and evaluate heat stress in dairy cattle.

The objective of this study was to evaluate the relationship between temperature humidity index (THI) and the changes in physiological responses and hematological aspects of buffaloes and cows under different climatic conditions in Egypt.

MATERIAL AND METHODS

Animals, management and feeding:

The data used in this study were collected from six Egyptian Governorates located in three different geographic regions (Lower, Middle and Upper Egypt). This work was conducted during the period from January (2010) to December (2015). Two Governorates from each region were visited to collect the data as follow: El Behera and El Menoufia, representing Lower Egypt region (LE) which contain the number of buffaloes and cows (384120, 537434 head) and (369684, 317229 head), respectively. Fayoum and El Menia represent Middle Egypt region (ME) which contain number of buffaloes and cows (190604, 291769 head) and (291739, 337987 head), respectively. Suhag and Qena

represent Upper Egypt region (UE) which contain number of buffaloes and cows (272915, 279845 head) and (213375, 195156 head), respectively. In each Governorate 25 farms randomly selected between small, medium and large farms, the measurements were taken from 20 animals divided into (10 buffaloes and 10 cows) in each farm, and divided into two groups (5calves less than year, 5calves more than year).

The environmental condition was assessed using air temperature (AT, °C) and relative humidity (RH, %) to calculate temperature humidity index (THI) according to equation of Mader *et al.* (2006) as following:

$$THI = (0.8 * T) + [(RH / 100) * (T - 14.4)] + 46.4$$

Where: T is air temperature ($^{\circ}$C) and RH is relative humidity (%).

THI classification according to physiological reaction of animals, the environmental regions based on THI values were classified into four classes (cold conditions, thermal neutral conditions, mild heat stress conditions and moderate heat stress conditions) (Table 1)

Physiological responses:

Hair temperature (HT, °C) and skin temperature (ST, °C) were recorded by using a digital thermometer, rectal temperature (RT,°C) by using clinical thermometer and respiration rate (RR, r/min) was counted from movements of the flank in one minute.

Hematological responses:

Blood samples were collected from jugular vein in heparinized tubes for determining hemoglobin concentration (Hb, g/100 ml). Hb was determined by a colorimetric method using hemoglobin testing kits by using Spectrophotometer.

Fresh blood samples were also collected for determination of Ht% that was obtained by applying a column of 100 mm repaginated blood in micro-hematocrit tubes. Samples were centrifuged for 15 minutes at 12000 r.p.m then the packed column was read against a scale as a percentage of blood columns,

The data were analyzed using SAS (2002), according to the following model:

$$Y_{ijklm} = \mu + T_i + G_j + A_k + B_l + (TG)_{ij} + (TA)_{jk} + (TB)_{il} + (GA)_{jk} + (GB)_{jl} + (AB)_{kl} + (TGA)_{ijk} + (TAB)_{ikl} + (GAB)_{jkl} + (TGAB)_{ijkl} + E_{ijklm}$$

Where:

Y_{ijklm}	Observation on the mth animals of the ith climatic region in the jth region conditions in the kth age of calves in the lth species,
μ	: Overall mean,
T_i	: Fixed effect due to the climatic region (i: 1 = Lower Egypt, 2 = Middl Egypt and 3 = Upper Egypt),
G_j	: Fixed effect due to the region conditions (j: 1 = cold, 2 = Thermo-neutral, 3 = Mild heat stress and 4 = Moderate heat stress),
A_k	: Fixed effect due to the age of calves (k: 1 = calves less than one year and 2 = calves greater than one year),
B_l	: Fixed effect due to the species (l: 1 = Buffaloes and 2 = Cows),
$(TG)_{ij}$	: The interaction between climatic region and region conditions,
$(TA)_{jk}$	: The interaction between climatic region and age of calves,
$(TB)_{il}$	: The interaction between climatic region and species,
$(GA)_{jk}$	: The interaction between region conditions and age of calves,
$(GB)_{jl}$	: The interaction between region conditions and species,

(AB)$_{kl}$	: The interaction between age of calves and species,
(TGA)$_{ijk}$	: The interaction between climatic region, region conditions and age of calves,
(TAB)$_{ikl}$	: The interaction between climatic region, the age of calves and species,
(GAB)$_{jkl}$	: The interaction between region conditions, the age of calves and species,
TGAB)$_{ijkl}$	: The interaction between climatic region, region conditions, the age of calves and species and
E$_{ijklm}$	: Random error assumed N.I.D. (0, σ²e).

The Regression coefficient (b) of temperature humidity index (THI) were measured as the regression of physiology and hematological traits on temperature humidity index (**SAS, 2002**),

Y=a+Xb, where: Y physiology and hematological traits, a= Intercept, X= temperature humidity index and b= the regression coefficient for Y on X.

The Accuracy (R^2): low (R^2 = 0 to R^2 = 30), moderate (R^2 > 30 to R^2 = 60) and high (R^2 > 60 to R^2 = 100).

RESULTS AND DISCUSSION

Environmental condition:

The means of THI from 2010 to 2015 in three regional climatic conditions are shown in Figure (1). The results indicated that the highest values of THI were found in August at Lower, Middle and Upper Egypt whereas the lowest values of THI were found in February at the same regions. The mean value of THI in Middle and Upper Egypt during February were similar while, in Lower and Middle Egypt the same value of THI was found in May, June and August. Also, similar THI values were detected in Middle and Upper Egypt in October and November.

The THI classes based on changes in physiological and hematological responses for the animals under different climatic conditions into three regions (in table 1): At Lower Egypt values of THI ≤ 60.20 cold, 60.20 < THI ≤ 74.40 thermo-neutral, 74.40 < THI ≤ 78.70 mild heat, and 78.70 < THI ≤ 89.92 moderate heat stress.

At Middle Egypt THI ≤ 57.60 cold, 57.60 < THI ≤ 73.00 thermo-neutral, 73.00 < THI ≤ 75.6 mild heat stress and 75.6 < THI ≤ 86.70 moderate heat stress.

At Upper Egypt THI ≤ 54.10 cold, 54.10 < THI ≤ 71.30 thermo-neutral, 71.30 < THI ≤ 73.3 mild heat stress and 73.30 < THI ≤ 84.90 moderate heat stress. Ravagnolo *et al.* (2000) reported that THI, based on the maximum temperature and minimum humidity most effectively accounted for the effect of heat stress on production. Estimating the thermal environment around animal is a key for understanding their needs, the performance of THI can be improved using a black globe humidity index, which adds the impact of solar radiation on ambient temperature around animals.

Fuquay (1981) reported that THI is commonly used as an indicator of the degree of climatic stress on animals where THI of 72 or less considered as no heat stress (cool), 73-77 as mild heat stress, 78-89 as moderate and above 90 as severe. Meanwhile, according to Davis *et al.* (2003) periods were deemed thermo- neutral when average THI < 70, mild heat stress when 70 ≤ THI ≤ 74, heat stress when THI 74 < THI ≤ 77 and severe heat stress when THI > 77.

Omran and Fooda (2013) working on buffaloes and Frisian calves in the Middle Egypt found that classes of THI based on changes in RT and RR with changes in THI were as follow: thermo-neutral when THI > 68, mild heat stress when 68≤ THI< 74, moderate heat stress when 74 ≤ THI < 82, severe heat stress when 82 ≤ THI < 87 and very severe heat stress when THI ≥ 87. On the other

hand, the associated classes of livestock weather safety index (LCI, 1970) are normal (THI ≤ 74), Alert (75-78 THI), a longer (79 - 83 THI) and emergency (THI>84). Khalil and Omran (2018) reported that influence of climatic change on temperature humidity index (THI) values were observed in different three regions (Lower of Egypt , Middle of Egypt ,and Upper of Egypt) during the period from 2016 up to 2060 gives evidence for significant changes in THI values during the period from 2046 to 2060.

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Physiological responses:

Table (2) display means and SE of physiological responses: hair temperature (HT°C), skin temperature (ST°C), rectal temperature (RT°C) and respiration rate (RR r/min) for two species. Values of HT, ST and RT were slightly higher in cows than in buffaloes among all studied regions. The young stock of both species exhibited higher HT and ST than the older animals. Despite higher estimates of HT and ST were observed for buffaloes and cows in Lower Egypt (LE) compared with those in Middle Egypt (ME), no abundant differences in HT or ST were found between animals in ME and UE. Both species showed increased HT and ST with elevated temperature in the different climates. It was interesting that ST values of buffaloes during winter were relatively higher than that of cows and greater than the corresponding estimates of other seasons. In the contrary, values of ST in buffaloes during the hot climate were almost similar in all regions. This finding indicated that buffaloes have the potentiality to maintain stability of ST within the different climatic conditions. It is postulated that blood circulation of the host animal plays an important role in this concern. This results celery in fig (2, 3, 4, 5) reflected the relationship between   temperature humidity index (THI) and Hair temperature (HT°C), Skin temperature (ST°C), Rectal temperature (RT, °C) and Respiration rate (RR r/min) all figures the highest values with THI under Lower Egypt for two ages and species., and the lower values with THI were under Upper Egypt .The buffaloes under three regional conditions recording lower values compared with cows. The body coat of an animal plays a major role in adoption and production under different climatic conditions (Hafez *et al.*, 1968 and Shafie and Omran 2018). The morphological characteristics of hair coat (HT) are markedly influenced by climate. Shafie and Omran (2018) reported that buffaloes are changing thickness of skin, length of hair, density of hair follicles and color of hair for acclamation with the surrounding conditions.

Values of RR and RT are a good measure of core temperature and have been used by many investigators to detect the response of animal to the environmental conditions (air temperature, relative humidity, seasonal and diurnal rhythm). The results indicated narrow changes in RT among the different seasons and regions. Meanwhile, RT of both species increased gradually with changes of the ambient temperature from winter to summer. The range of RT in the older cows from winter to summer lies between 38.0 - 39.4 C° while that of the young animals lies between 38.1-40.0 C°. The corresponding range of RT in buffaloes was 37.3- 38.9 C°, respectively.

RRr/min is the first reaction when animals are exposed to environmental temperature above the thermo-neutral zone. This physiological response ensures direct heat stimulation of the peripheral receptors which transmit nervous impulses to the heat center in the hypothalamus. In the current study, values of RR were relatively higher in the young animals as compared with the older animals of both species. However, the variance in RR between age categories of cattle was increasing in concomitant with the higher seasonal temperatures. Values of RR for both species were the highest at LE followed by ME and UE. The differences between species in RR were highly significant, so that the range of RR in cattle lies between 39.3-54.6 r /min while in buffaloes it was 32.3- 40.5 RR r/min. This finding clarified the ability of buffaloes to dissipate the influence of heat stress through different internal mechanisms. In general, Shafie (1985, 1993 a & b and Shafie and Omran (2018) stated that

the morphological, anatomical and physiological characteristics of buffaloes have more suitability to hot conditions.

Shafie and El-Sheikh Aly (1970) reported that the increased body reaction in cows from the morning to the afternoon could be attributed to the gradual rise in atmospheric temperature, the increase in body activity of the animal and the increase of RR during the hot seasons as the most sensitive physiological response to heat exposure.

Omran and Fooda (2013) recommended avoiding raising Friesian cows under environmental conditions with greater than 87 THI index or raising buffaloes under environmental condition with greater than 91 THI index. The best THI index for production in both species is lower than 68 THI but buffaloes start to be under cold stress at this threshold. Friesian cows are more cold tolerant and suitable than buffalos under natural environmental condition at ME. Collier et al. (2006) found that, the ST is highly correlated with respiration rates and it is a good measure of microenvironment around the animals. They also added that, if the skin surface temperature is blow 35 °C, the temperature gradient between the core and skin is large enough for the animals to affectively use all routes of heat exchange.

Omran *et al.* (2017) used product containing anaerobic bacteria and mixture of natural celluletic enzymes as dietary supplement (ZAD) for buffaloes. They observed that ZAD feeding reduced the harmful effects of cold waves through improving postpartum physiological status and reducing sensitivity of buffaloes to cold climatic changes.

Hematological responses:

Table (3) show means and SE of hematological response: hematocrit (Ht, %) and hemoglobin (Hb), for buffaloes and cows. The results showed that percentages of Ht in buffaloes varied between 27.0% - 36.1% while it was 24.2% - 35.3% in cows. On the other hand, concentrations of Hb in buffaloes varied between 10.3 - 14.1 g/100 ml while it was 9.7 - 13.9 g/100 ml in cattle. In both species, estimates of Ht % and concentrations of Hb were relatively higher in the young animals than those of the older ones except that Ht% and Hb values recorded during winter were slightly less than those of the older animals. Also, values of Ht% during winter were less than those recorded in other seasons regardless of age category or species. Meanwhile, with subsequent increase in the ambient temperatures Ht % values descended relatively in both species. Value of Ht was noticeably greater in both species of UE compared with LE. or ME.

Estimates of Hb for young or older buffaloes were slightly higher than those of cattle except those values recorded in the winter season. While, estimates of Hb in cows were descending with the increase of environmental temperatures among all seasons, values of Hb in buffaloes followed similar pattern except in winter. Values of Hb were variable for both species within the different regions of the study Finger(6,7)the relationship between temperature humidity index (THI) and hematocrit Ht% and hemoglobin concentration Hb, g/100ml for buffaloes and cows under differ ages and climate regional climatic conditions. ,the values of buffalos in two ages were higher than cattle for Ht and Hb, , Ht is a sensitive indicator to the surrounding thermal condition when compared with Hb concentrations.

Most species of domestic animal have Ht values from 38 to 40 % (Swenson and Reece 2005). Shafie and Badreldin (1962) found that exposing buffaloes and baladi cows to sun ray decreased Ht values by 7.2 % and 1.8 %, respectively, added to decreased Hb concentration in both species under heat stress. Values of Hb in normal blood of most mammals lies between 13 to 15 g/dl. Many investigators reported that Hb value decreased as a result of exposing animals to high AT in lab or under normal environmental condition (Yousef, 1990; Ashour et al. 2004 and Omran et al. 2013).

Omran et al. (2011b) reported that blood picture for buffalo calves showed clear drop in Ht and Hb values and increased count of white blood cells (WBCs) under heat stress. Such change may refer partially to hemodilution by the excess of water intake. The drop in Hb and red blood cells (RBCs) was more pronounced than the decline in Ht which indicate other mechanism imposing drop in Hb and RBCs to reduce oxidation activity of metabolism followed by drop in metabolic heat production. On the contrary, WBCs count was increased as indication of higher immunological activity.

In agreement with the present results, Omran (2011a) reported that the values of Ht, Hb and RBCs in general were lower in Friesian cows than buffaloes. The author attributed the higher estimates of HT and Hb in buffaloes to adaptability of the animal and fast recovery from heat stress as compared with Friesian and local cows, denoting the buffaloes can alleviate the heat stress through evaporation from skin and the respiratory system.

Shafie and Badreldin (1962) found that Egyptian buffaloes had higher Hb, RBCs values than Egyptian Balady cows they discussed that higher by metabolic heat production due to the high oxygen tension of blood, this was drawback for adaptation to hot climates where the animals mostly tried to keep their metabolic rate low level.

Table (4and5) show mean squares and degree of freedom for physiological responses and hematological responses, values were high significant ($P \leq 0.001$) in all parameters for regions, environmental condition, age and species. The interaction between region with environmental, age and species values were high significant ($P \leq 0.001$) in all parameters except of ST ($P \leq 0.05$).

The interaction between environmental condition with age and species values were higher significant ($P \leq 0.001$) in all parameters. The interaction between age and species values were high significant ($P \leq 0.001$) in all parameters except value of Hb ($P \leq 0.01$). The interaction between regions with environmental condition with age values were high significant ($P \leq 0.001$) in all parameters.

The interaction between regions with age with species values were high significant for all parameters except of ST value was non-significant. The interaction between environmental condition with age with species values were high significant ($P \leq 0.001$) in all parameters except of RT ($P \leq 0.01$). The interaction between regions with environmental condition with age with species age values were high significant ($P \leq 0.001$) in all parameters.

The wide ranges of environmental temperatures that comprise thermo-neutral zone enable animals to maintain their heat balance across the rough vasomotor control by regulating the amount of blood flowing through the coetaneous vessels by either vasodilatation or vasoconstriction. Omran (1999) reported that with advancement of calf age, slight changes were detected in estimates of Hb or RBCs for buffaloes and Frisian calves. The highly significant differences for all tested parameters in the present study indicated that Upper and Middle Egypt represent better comfort zones for raising buffaloes or cows as compared with Lower Egypt. However, it was noticed that cows were more tolerant in the cold weather while, buffaloes have a particular sensitivity to cold waves.

Table (6) shows the equations used for predicting the changes in adaptive physiology and hematology with the expected changes in THI for two species. 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 THI index for any region is helpful to predict the physiological and hematological changes of the breed so that an appropriate animal can be chosen for breeding in assigned region where it can express its genetic potential in the suitable environment for production. Khalil and Omran (2018) reported that influence of climatic change on temperature humidity index (THI) values were observed in different three regions (Lower of Egypt , Middle of

Egypt ,and Upper of Egypt) during the period from 2016 up to 2060 gives evidence for significant changes in THI values during the period from 2046 to 2060.

The classifications of THI during the study period found that the moderate class shows a gradual increase with time in all studied 12 governorates. Behavioral and physiological responses initiated to increase heat loss and reduce heat production which could be considered as an attempt to maintain body temperature within the range of normality,

Using the predictive equations can enable the animal holder to make any modification to maintain productivity of animal.

CONCLUSION

Results of the present study clarified that; animal RR r/min is faster indicator to any changes in the microenvironment when compared with the slow alterations in ST C°. On the other side, Ht % is a sensitive indicator to the surrounding thermal condition when compared with Hb g/dl concentrations reason for the thermal condition around animals. Therefore, RR and Ht % can be used as good indicator to animal stressed.

Cows were more adaptive to the Egyptian cold climates especially in Upper and Middle Egypt. On the other hand, buffaloes were sensitive to cold waves of winter while they were more adapted than cows under heat stress condition in all regions. Buffaloes can be more adapted to cold weather if some modifications were adopted to reduce impact of cold waves such as using protective shades and wind breaks in animal housing. Also, increasing the dietary energy level and improving ruminal fermentation and digestibility of feedstuff using specific supplements can stimulate the animal feed intake to fulfill body requirement of energy.

Since THI is commonly used as relevant indicator of the degree of climatic stress on animal productivity, the classifications of the environmental regions in Egypt using this index in the present work based on adaptive and hematological changes of animals pointed out that Lower Egypt is climatic more stressful in comparison with Middle and Upper Egypt. Moreover, the close relationship between THI and the tested responses including animal RR and Ht % in particular, revealed the ability of using those parameters as predictive measures for animal acclimation in each specific region. Thus, livestock holder has the choice to select the appropriate breed for raising to get efficient productivity according to compatibility with his farm location. Using the predictive equations can enable the animal holder to make any modification to maintain productivity of animal.

Table (1) Classification of the environmental regions based on temperature humidity index (THI) values.

Environmental regions	Lower Egypt	Middle Egypt	Upper Egypt
Cold	60.20	57.60	54.10
Thermo- neutral	74.40	73.00	71.30
Mild heat stress	78.70	75.60	73.30
Moderate heat stress	89.92	86.70	84.90

Table (2). Mean ± SE for hair temperature (HT, °C), skin temperature (ST, °C), rectal temperature (RT, °C) and respiration rate (RR, r/min) for buffaloes (B) and cows (C) aging less than (G1) or more than (G2) one year under different climatic conditions of three regions (lower, middle and upper Egypt)

During cold conditions

Items	Lower Egypt (THI 56.9 - 62.0)				Middle Egypt (THI 51.7 - 61.6)				Upper Egypt (THI 55.3 - 60.1)			
	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
HT	32.8±0.10	34.2±0.09	30.8±0.14	33.9±0.22	31.3±0.07	33.9±0.08	30.5±0.07	32.2±0.12	30.8±0.13	32.3±0.09	30.1±0.15	33.1 ±0.04
ST	35.8±0.07	36.9±0.03	34.1±0.07	35.7±0.03	35.0±0.07	35.9±0.02	35.•±•.02	35.8±0.05	36.0±0.04	36.1±0.05	34.0±0.06	34.0±0.03
RT	37.8±0.06	38.4±0.03	37.6±0.02	38.0±0.03	37.3 ±0.04	38.6±0.03	37.6±0.01	38.0±0.02	37.8±0.04	38.1±0.04	37.3±0.02	38.0 ±0.03
RR	23.7±0.22	26.8±0.26	20.3±0.13	25.3±0.34	22.04±0.19	25.2±0.14	19.0±0.16	24.4±0.24	20.2±0.06	24.0±0.16	17.0±0.14	23.5±0.11

During thermo neutral condition

Items	Lower Egypt (THI 59.8 - 72.4)				Middle Egypt (THI 59.2 - 71.0)				Upper Egypt (THI 57.4 - 69.3)			
	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
HT	34.4±0.10	35.0±0.08	33.5±0.05	35.0±0.06	33.5±0.05	34.2±0.07	32.0±0.09	34.1±0.09	33.2±0.09	34.1±0.20	32.6±0.02	33.1 ±0.07
ST	35.9±0.11	36.8±0.07	34.5±0.05	35.5±0.03	35.6 ±0.04	36.5±0.05	34.3±0.05	35.0±0.03	35.0±0.10	36.0±0.04	33.1±0.02	34.2±0.01
RT	38.0±0.02	38.5±0.02	37.9±0.05	38.4±0.03	38.0±0.02	38.4±0.03	37.6±0.03	38.1±0.02	37.2±0.03	38.2±0.05	37.5±0.05	38.2 ±0.02
RR	28.0±0.31	34.6±0.29	26.8±0.60	28.1±0.14	26.4±0.14	33.1±0.07	25.0±0.26	28.1±0.17	24.9±0.15	30.0±0.12	23.1±0.20	26.3±0.22

During mild heat stress condition

Items	Lower Egypt (THI 68.7 - 78.0)				Middle Egypt (THI 59.7 - 74.6)				Upper Egypt (THI 57.4 - 71.3)			
	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
HT	36.0±0.06	36.6±0.04	36.0±0.10	36.0±0.07	34.3 ±0.04	36.3±0.03	33.9±0.05	35.5±0.02	34.5±0.09	35.6±0.08	33.9±0.03	35.0 ±0.03
ST	36.9±0.07	38.0±0.06	36.1±0.04	37.1±0.04	36.3±0.04	37.3±0.05	35.6±0.03	36.1±0.03	35.9±0.02	36.6±0.03	35.0±0.03	36.4±0.03
RT	38.5±0.03	39.2±0.03	38.2±0.02	38.5±0.04	38.3±0.03	39.0±0.04	38.0±0.02	38.0±0.03	38.3±0.04	38.4±0.04	38.0±0.03	38.1±0.01
RR	32.9±0.39	39.4±0.26	30.7±0.28	36.9±0.35	32.0±0.14	37.6±0.13	28.4±0.18	35.6±0.13	27.1±0.29	34.0±0.23	26.9±0.25	30.9 ±0.08

During moderate heat condition

Items	Lower Egypt (THI 69.9 - 79.0)				Middle Egypt (THI 68.2 - 77.7)				Upper Egypt (THI 65.9 - 72.5)			
	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
HT	36.7±0.03	37.1±0.05	36.0±0.09	36.6±0.03	36.0 ±0.05	36.8 ±0.02	35.5±0.04	36.3±0.05	35.8±0.05	36.5±0.03	35.4±0.11	36.0±0.03
ST	37.1±0.06	37.9±0.03	36.9±0.03	37.6 0.04	36.9 ±0.06	37.7 ±0.06	37.0±0.03	37.6 0.05	37.2±0.02	38.2 0.01	37.0±0.02	37.4±0.02
RT	38.9±0.02	40.0±0.02	38.5±0.04	39.4±0.06	38.8±0.03	39.4±0.05	38.0±0.03	39.0±0.05	38.4±0.02	39.3±0.02	38.0±0.04	39.0±0.01
RR	40.5±0.33	54.6±0.68	35.0±0.58	43.5±0.89	38.2±0.46	48.5±0.63	33.5±0.32	39.8±0.48	35.6±0.16	46.1±0.44	32.3±0.24	39.3±0.17

Table (3). Mean ± SE for hematocrit (Ht, %) and hemoglobin concentration (Hb, g/100 ml) for buffaloes (B) and cows (C) aging less than (G1) or more than (G2) one year under different climatic conditions of three regions (lower, middle and upper Egypt).

	During cold conditions											
	Lower Egypt				Middle Egypt				Upper Egypt			
Items	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
Ht	31.8±0.75	32.0 ±0.37	32.3±0.11	33.4±0.13	29.9±0.18	30.7±0.93	30.9±0.08	33.5 ±0.05	29.2±0.15	35.1±0.46	30.9 ±0.14	33.9±0.17
Hb	11.2±0.15	12.8±0.07	11.7±0.09	11.9±0.09	10.6±0.11	12.3±0.07	11.0±0.03	13.0 ±0.09	10.9±0.11	13.9±0.11	11.32±0.10	13.0±0.11
	During thermo neutral condition											
	Lower Egypt				Middle Egypt				Upper Egypt			
Items	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
Ht	35.1±0.20	33.4±0.12	33.4±0.20	32.4±0.10	34.7±0.04	34.7±0.07	32.5±0.18	32.4±0.08	36.1±0.09	35.3±0.12	34.0±0.06	33.5±0.10
Hb	13.8±0.05	13.2±0.10	13.3±0.05	12.8±0.10	13.7±0.07	13.7±0.08	12.8±0.07	12.2 ±0.05	14.1±0.08	13.1±0.06	13.0 ±0.07	12.1±0.07
	During mild heat stress condition											
	Lower Egypt				Middle Egypt				Upper Egypt			
Items	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
Ht	30.6±0.09	28.9±0.15	29.5±0.12	28.1±0.17	31.4±0.10	29.0±0.15	30.5±0.12	28.2 ±0.11	33.6±0.11	30.1±0.20	32.0±0.08	28.8±0.03
Hb	11.8±0.09	11.11±0.11	11.1±0.12	9.9±0.13	11.8±0.11	11.0±0.06	11.5±0.07	10.18±0.02	12.8±0.08	11.0±0.06	12.0±0.07	11.8±0.03
	During moderate heat condition											
	Lower Egypt				Middle Egypt				Upper Egypt			
Items	G1		G2		G1		G2		G1		G2	
	B	C	B	C	B	C	B	C	B	C	B	C
Ht	28.5±0.19	26.8±0.32	27.2±0.20	24.2±0.22	27.8±0.11	26.2±0.24	27.0±0.18	25.0 ±0.18	29.5 0.29	28.3±0.38	28.0±0.05	27.4±0.20
Hb	10.9±0.06	10.0±0.09	10.3±0.05	9.7±0.08	10.9±0.03	10.2±0.11	10.7±0.09	9.8±0.05	11.5±0.07	10.9±0.07	10.8±0.06	10.5±0.08

Table (6). Equations for predicting the changes in adaptive physiology and hematological traits of buffaloes and cows with the expected changes in THI.

Buffaloes		Cow	
Equation	R^2 (%)	Equation	R^2 (%)
HT = 20.00 + 0.21(THI)[***]	51	HT = 25.18 + 0.15(THI)[***]	48
ST = 31.49 + 0.07(THI)[***]	27	ST = 32.24 + 0.07(THI)[***]	30
RT = 36.15 + 0.03(THI)[***]	34	RT = 35.26 + 0.05(THI)[***]	44
RR = -10.98 + 0.59(THI)[***]	50	RR = -21.55 + 0.86(THI)[***]	45
Ht = 35.97 + (-0.08)(THI)[***]	10	Ht = 49.10 + (-0.29)(THI)[***]	38
Hb = 12.33 + (-0.01)(THI)[ns]	0	Hb = 18.26 + (-0.10)(THI)[***]	25

*** : P $\leq$ 0.001   ns::Not significant P$\geq$00.05
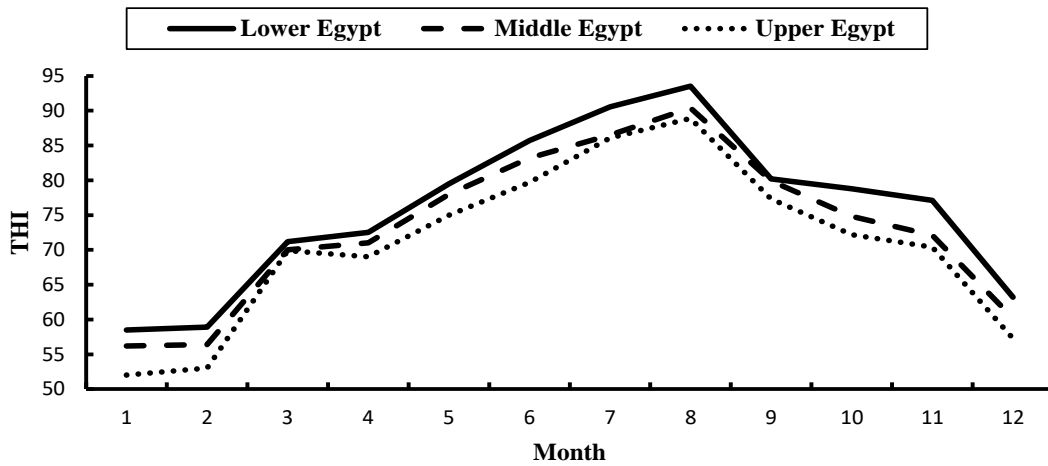
Fig. (1) Monthly trend of THI values from 2010 to 2015 as recorded in three regional Climatic conditions in Egypt.
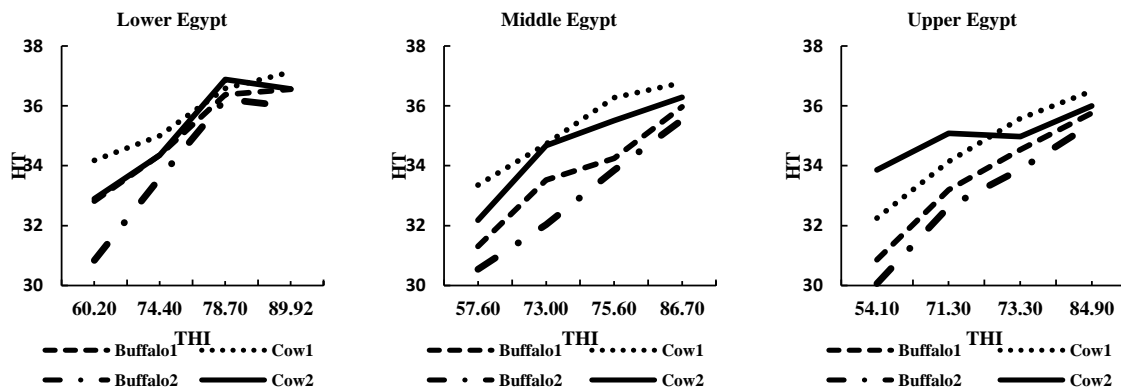
Fig. (2). Relationshep between temperature humidity index (THI) and hair temperature (HT, °C) for buffaloes and cows under differ ages and climat regional condition.

Buffalo1: Buffalo age < 1year, Cow1: Cow age < 1year, Buffalo2: Buffalo age > 1year and Cows 2: Cow's age > 1year
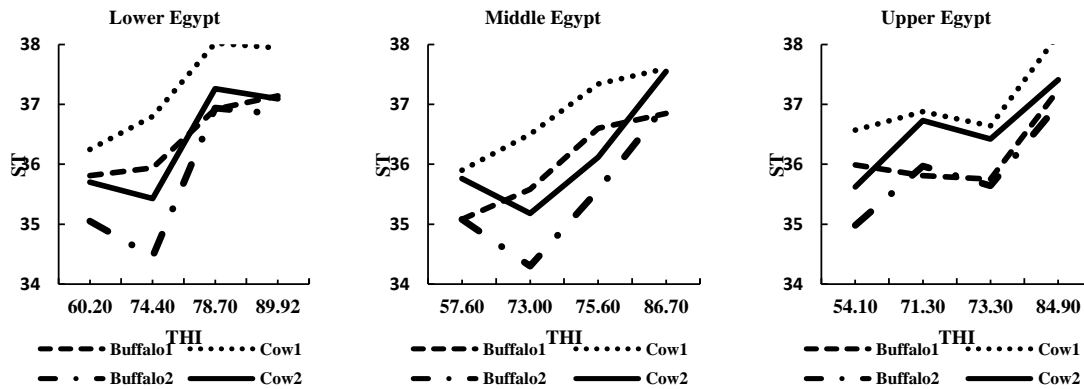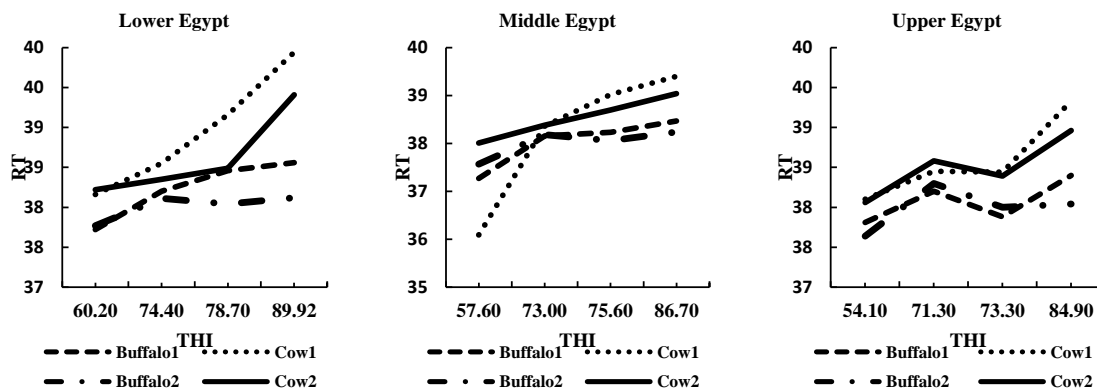

Fig. (3). Relationshep between temperature humidity index (THI) and skin temperature (ST, °C) for buffaloes and cows under differ ages and climat regional conditions.

Buffalo1: Buffalo age < 1year, Cow1: Cow age < 1year, Buffalo2: Buffalo age > 1year and Cows 2: Cow's age > 1year

Fig. (4). Relationshep between temperature humidity index (THI) and rectal temperature (RT, °C) for buffaloes and cows under differ ages and climat regional conditions.

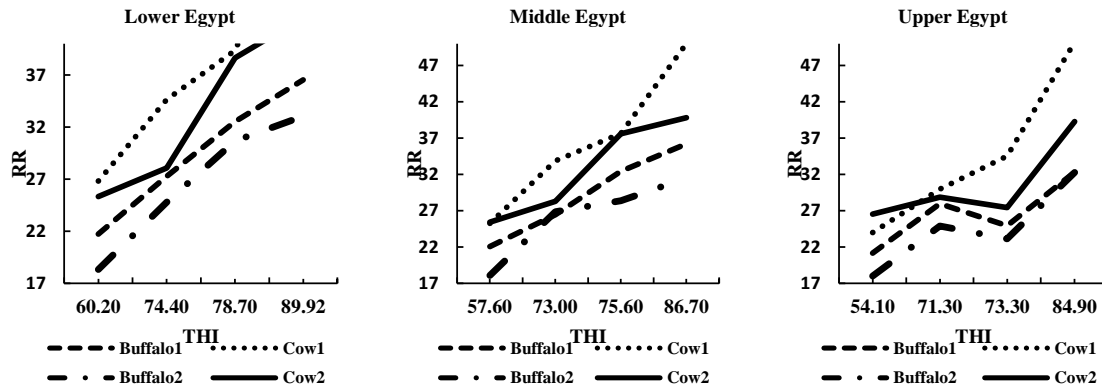Buffalo1: Buffalo age < 1year, Cow1: Cow age < 1year, Buffalo2: Buffalo age > 1year and cCws 2: Cow's age > 1year

Fig. (5). Relationshep between temperature humidity index (THI) and respiration rate (RR, r/min) for buffaloes and cows under differ ages and climat regional conditions.

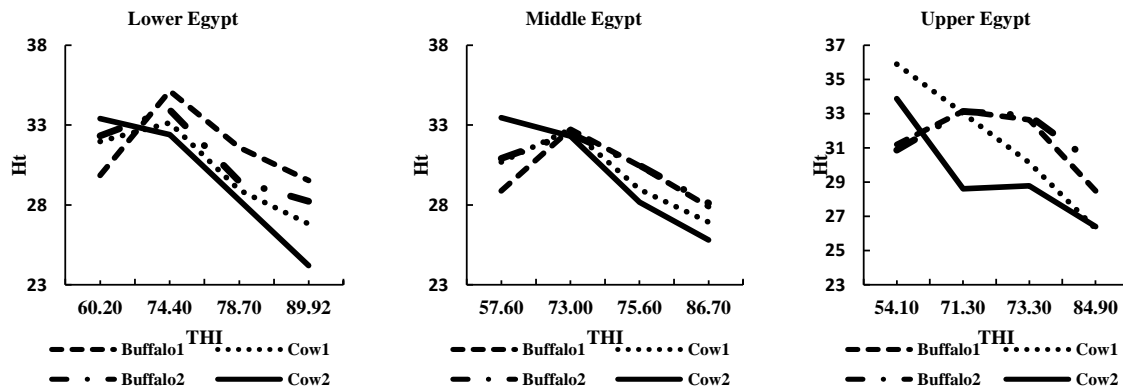Buffalo1: Buffalo age < 1year, Cow1: Cow age < 1year, Buffalo2: Buffalo age > 1year and Cows 2: Cow's age > 1year

Fig. (6). Relationshep between temperature humidity index (THI) and hematocrit (Ht, %) for buffaloes and cows under differ ages and climat regional conditions

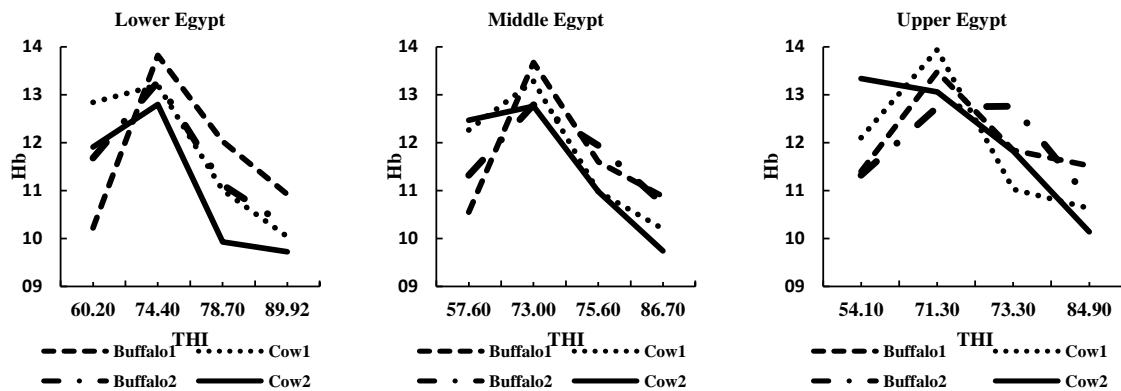Buffalo1: Buffalo age < 1year, Cow 1: Cow age < 1year, Buffalo2: Buffalo age > 1year and Cows 2: Cow's age > 1year

Fig. (7). Relationshep between temperature humidity index (THI) and hemoglobin concentration (Hb, g/100 ml) for buffaloes and cows under differ ages and climat regional conditions.

Buffalo1: Buffalo age < 1year, Cow 1: Cow age < 1year, Buffalo2: Buffalo age > 1year and Cows 2: Cow's age > 1year

REFERENCES

Ashour, G.; L. R. Hassan; F. I. Omran and M. M. Shafie (2004). Thermo-respiratory responses hematological and hormonal reactions of buffalo and Friesian calves to the rise in environmental temperature. Egyptian J. Anim. Prod., 41 Suppl. Issue, Nov., 353.

Buffington, D. E.; Collazo-Arocho, A.; Canton, G. H.; Pitt, D.; Thatcher, W. W. and Collier, R. J. (1981). Black Globe-Humidity Index (BGHI) as comfort equation for dairy cows. Trans. ASAE, 24(4): 711-714.

Collier, R. J.; G. E. Dahl and M. J. VanBaale (2006). Major advances associated with environmental effects on dairy cattle. J. Dairy Sci., 89: 1244-1253.

Davis, M. S.; T. L. Mader; S. M. Holt and A. M. Parkhurst (2003). Strategies to reduce feedlot cattle heat stress: Effects on tympanic temperature. J. Anim. Sci. 81: 649-661.

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

EARI (2017). Economic Agricultural Research Institute.

FAOSTAT (2017). FAO Statistics Division. Fao, Rotme, Italy.

Fuquay, J. W. (1981). Heat stress as it affects animal production. J. Anim. Sci. 52: 164-174.

Hafez, E. S. E. (1968). Principles of Animal Adaptation. *Ecological and Bioclimatological aspects*. Chapter 1, 3-18.

Hahn, G. L.; T. L. Mader and R. A. Eigenberg (2003). Perspective on development of thermal indices for animal studies and management. Interactions between climate and animal productions. EAAP Technical Series No. 7: 31-45.

IPCC (2013). Intergovernmental Panel on Climate Change. http://www.ipcc.ch/report/ar5/wg1/.

Khalil, A. A.and Omran F.I.(2018). Impact of climate change on temperature humidity index values in Egypt. .In. , J. of .Sc, Engineering and Technology V. (4) 1:1059-1064.

Khalifa H.H. (2003). Bioclimatology and Adaptation of Farm Animals in a Changing Climate. Interactions between Climate and Animal Production, Satellite Symposium 54th Annual Meeting EAAP, September 4th, 2003.

Johnson, H.D. (1987). Bioclimate effects on growth, reproduction and milk production. In: Johnson HD (ed) Bioclimatology and the adaptation of livestock. Elsevier, Amsterdam, pp 35-57

LCI (1970). Laboratory for Agricultural Climate Institute.

Mader, T. L.; M. S. Davis and T. Brown-Brandl (2006). Environmental factors influencing heat stress in feedlot cattle. J. Anim. Sci., 84: 712-719.

Marai, I. F. M and A. A. M. Habeeb (2010). Buffalo biological functions as affected by heat stress a review. Livestock Science, 127: 89-109.

Marai, I. F. M.; A.A.M. Habeeb and A.E. Gad (2002). Rabbit's productive, reproductive and physiological traits as affected by heat stress (a review) Livestock Production Science, 78: 71-90.

Omran, Fayza I. (1999). Physiological reaction and growth performance of buffaloes and Friesian calves to heat stress. M. Sc. Thesis, Fac. Agric., Cairo Univ., Giza, Egypt, P 147.

Omran, Fayza I. and T. A. Fooda. (2013) Thermal discomfort index for buffalo and Friesian under Egyptian condition. The 4Th scientific conference of Animal production Research Institute (April), Cairo, Egypt 12-13 November pp: 33-42.

Omran, I. Fayza, Omran, Mahgoub, A. A. S. and Fooda, T. A. (2017). Effect of biological additive on physiological and Production performance of buffaloes during Cold weaves stress in mid of the Egyptian valley. Egypt J. Agric. Res., 95 (4), 2017.

Omran, Fayza I.; G. H., Ashour; Laila R. Hassan; M. M. Shafie and M. M.Youssef (2011a). Physiological responses and growth performance of buffalo and Friesian calves under chronic severe heat stress. Proc. of the 4th Animal Wealth Research Conf. in the Middle East & North Africa. Foreign Agricultural Relations (FAR), Egypt, 3 -5 October, pp. 01–13.

Omran, Fayza I.; M. M. Shafie; G. H. Ashour; Laila R. Hassan and M. M. Youssef (2011b). Physiological reaction and growth performance of buffalo and Friesian calves after recovery from heat stress. Proc. of the 4th Animal Wealth Res. Conf. in the Middle East & North Africa, Foregin Agricultural Relations, Egypt, 3-5 October, pp. 78-94.

Omran, Fayza. I.; M. M. Shafie; G. H. Ashour; M. M. Youssef and Laila R. Hassan (2013). Responses of buffalo calves exposed to first and second acute thermal shocks. Egypt J. Agric. Res. 91(3). pp: 1113-1129.

Ravagnolo, O.; I. Misztal and G. Hoogenboom (2000). Genetic component of heat stress in dairy cattle, development of heat index function. J. Dairy Sci., 83: 2120 - 2125.

SAS (2002). SAS User's Guide. Statistical Analysis System. Institute, Inc., Cary, NC.

Shafie, M. M. (1985). Physiological responses and adaptation of water buffalo. In Stress Physiology In Livestock, Vol. 11, M. K. Yousef (Ed.) Ungulates, CRC, Florida, USA, 67.

Shafie, M. M. (1993a). Biological adaptation of buffaloes to climatic conditions. Egyptian J. Anim. Prod., 176.

Shafie, M. M. (1993b). Environmental effects on water buffalo production. World Anim. Rev., FAO, 77, 21.

Shafie, M. M. and A. L. Badreldin (1962). The role of blood in regulating body heat in bovines. Egyptian J. Anim. Prod., 2: 62.

Shafie, M. M. and F. I. Omran (2018). Adaptivity of buffalo calves to differ thermal conditions. Egypt J. Agric. Res., 96 (2),

Shafie, M. M. and I. F. M. Marai (1966). Skin glands and layers in some breeds of sheep. Egyptian J. Anim. Prod., 6: 117.

Shafie, M. M. and L. El-Sheikh Aly (1970). Heat tolerance of Friesian cattle under Egyptian climatic conditions. Egyptian J. Anim. Prod., 10: P. 99.

Shafie, M. M.; H. M. Murad; T. M. El-Bedawy and S. M. Salem (1994). Effect of heat stress on feed intake, rumen fermentation and water turnover in relation to heat tolerance response by sheep. Egyptian J. Anim. Prod., 31: P. 317.

Swenson, M. J. and W. O. Reece (2005). Duck's Physiology of Domestic Animals. Cornell Univ. Press, Ithaca USA, 40.

Yousef, H. M. (1990). Studies on adaptation of Friesian cattle in Egypt. Ph. D. Thesis, Fac. Agric., Zagazig Univ., Zagazig, Egypt.

الاداء الفسيولوجى والهيماتولوجى لدم للجاموس والابقار تحت ظروف الاقاليم المناخيه المختلفه فى مصر

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الملخص العربي

هذه الدراسه تهتم بايجاد العلاقه بين دليل الحراره والرطوبه والتغير فى الاستجابه الفسيولوجيه والهيماتولوجى لدم للجاموس والابقار تحت الظروف المناخيه الختلفه فى مصر. تم تجميع بيانات هذه الدراسه فى الفتره من يناير ٢٠١٠ الى ديسمبر ٢٠١٥. ٦ محافظات ممثله لثلاث مناطق جغرافيه مختلفه (مصر السفلى , مصر الوسطى ,مصر العليا) وتم جمع البيانات من محافظتين لكل منطقه, فى كل محافظه ٢٥ مزرعه تم اختيارها عشوائى مابين مزارع صغيره , متوسطه وكبيره ,وكانت القياسات تؤخذ من عدد ٢٠ حيوان مقسمه (١٠ عجول جاموس و١٠عجول من الابقار) فى كل مزرعه وتم تقسيم كلا من الجاموس والابقار الى مجموعتين المجموعه الاولى ٥عجول اقل من سنه والمجموعه الثانيه ٥ عجول اكبر من سنه,قياسات الظروف البيئيه وكان يتم تسجيل درجات الحراره والرطوبه النسبيه لحساب دليل الحراره والرطوبه .وتم التقسيم على اساس دليل الحراره والرطوبه الى ٤ اقسام (بروده ,حراره مثلى ,اجهاد حرارى خفيف ,اجهاد حرارى). وتقدير الاستجابه الفسيولوجيه للحيونات ممثله فى درجه حرارة الشعر والجلد وحراره الجسم (درجه مئويه) ومعدل التنفس فى الدقيقه واخذ عينه دم لتقدير الهيماتوكريت والهيموجلوبين.

وكانت اهم النتائج: درجه حرارة الشعر والجلد والمستقيم، معدل التنفس فى الدقيقه كان اعلى فى الابقار مقارنه بالجاموس خلال مناطق التجربه. سجلت اعلى قيم للجلد والشعر فى الجاموس والابقار كانت فى مصر السفلى مقارنه بمصر الوسطى، فى الجاموس والابقار كانت الزياده فى درجه حرارة الجلد والشعر متلازمه مع درجه حرارة ا لمناخ المختلفه. التغير فى درجه حرارة الجسم تختلف باختلاف المنطقه. بينما قيم معدل التنفس للجاموس والابقار كانت اعلى ى مصر السفلى يليها الوسطى ثم العليا. ولوحظ ان جلد الجاموس ثابت تحت الظروف المناخيه المختلفه، وحساسيه الجاموس للبروده وثبات الخصائص الفسيولوجيه للجاموس للحراره مقارنه بالابقار.

قيم الهيماتوكريت كانت منخفضه فى الشتاء. ومتدرجه مع العمر والنوع. قيم الهيماتولوجى اعلى للنوعين فى مصر العليا مقارنه بمصر السفلى او مصر الوسطى. الدراسه توضح مقدره استخدام معدل التنفس ونسبه الهيماتوكريت كمقياس لتاقلم الحيوان مع دليل الحراره والرطوبه لكل منطقه. لذلك لتربيه الحيوانات يتم اختيار النوع المناسب للمنطقه من خلال معادلات التنبؤ ليعطى الحيوان كفائه انتاجيه للمزرعه حسب مكانها.