Egyptian J. Anim. Prod., Vol. 31, Supplement Issue, Nov. (1994): 333-346.

TEMPERATURE GRADIENTS OF JERSEY COWS IN UPPER EGYPT

M. Zenhom[1] and H.A. Daghash[2]

1- Mallawy Research Station of Animal Production, Animal Production Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt 2- Department of Animal Production, Faculty of Agriculture, University of Assiut, Assiut, Egypt

SUMMARY

Body, skin and hair temperatures in six regions of ten Jersey cows (average age 4-5 years) were used to calculate temperature gradients of such cows in different seasons and body regions. Results indicated that the temperature gradients of body temperature to skin temperature (BT-ST) decreased from winter to autumn. The same direction was observed in the temperature gradients of both body temperature to air temperature (BT-AT) and skin temperature to air temperature (ST-AT) as well as hair temperature to air temperature (HT-AT). In summer, the minimum temperature gradients were observed for body temperature to hair temperature (BT-HT) and skin temperature to hair temperature (ST-HT).

Concerning body regions, the neck and the mid-dorsal regions exhibited the highest temperature gradients of (BT-ST) and (BT- HT) than any regions of the body while the flank region exhibited the lowest temperature gradients of(BT-ST) and (BT-HT). Reversly, the neck and the mid-dorsal regions showed the lowest temperature gradients of (ST-AT) and (ST-HT) as well as (HT-AT) while the flank region showed the highest one.

On the other hand, interaction between seasons and body regions indicated that winter showed the highest temperature gradients of (BT-ST) than any seasons in all body regions. The same trend was observed in winter for temperature gradients of (BT- HT), (ST- AT), (ST-HT) and (HT-AT). However, summer showed the minimum temperature gradients of (BT-HT) and (ST-HT) nearly in all body regions while the other three gradients (BT-ST),(ST- AT) and (HT-AT) had minimum gradients in autumn than other seasons. Further, (HT-AT) gradients had negative values in autumn in all body regions except flank indicating that hair gained heat from the surrounding environment in autumn at such regions.

These results indicated that gradients were high at winter in all positions and reverse at summer and autumn, indicating the end of physical ways of heat loss during hot seasons.

Keywords: Jersey cows, temperature gradients, seasons and body regions

INTRODUCTION

Energy flow to the animal are primarily caused by environmental factors such as air temperature (AT), sky temperature,solar radiation, thermal radiation,wind speed, humidity and geometric structural properties of animal coat such as hair length, denisty, diameter, pelt thickness, colour, hair transmissivity and absorptivity (Gebremedhin, 1985). When AT is cool, the body loses most of the heat by ways of radiation,conduction and convection due to Neutan's low of cooling. As the AT increased, the pervious ways of heat dissipation become gradually less efficient and water evaporation becomes more reliable for heat regulation. If AT rises more, the revrese occure,the animals begin to absorb heat through radiation,convection and conduction. In this field, Gebremedhin (1985) reported that if the AT is cooler than the surface temperature of the animal, then energy is lost from the animal to the air by convection and conduction in the boundry layer of air next to the animal surface. If the air is warmer than the animal surface temperature, then convection will add heat to the animal. If there is no wind movement i.e.quiescent condition, convection still occurs in the form of free convection set up by the temperature differential between the animal surface and the air, but is small and negligible. In addition to convection, heat may be exchanged by direct conduction if the animal is in contact with a substrate at a different temperature. The efficiency of heat dissipation mechanism through radiation,conduction and convection declines with the increase in AT and it reachs zero when the surface temperature (skin+hair) equals air temperature (Shafie and Badreldin, 1963 and Darwish et al., 1972).

The rate of thermal exchange depends on the ability of the environment to accept heat and water vapour (Finch, 1986). Resistance to these exchanges prevents heat loss and rise BT. Resistance to nonevaporative heat transfer is proportional to the temperature gradients within the animal and between it and the environment, and is inversly proportional to the heat-flux moving between these gradients. If ST approaches BT, resistance to heat removal must be lower or heat will be stored increasing BT.If AT exceeds ST or if an animal is in sunlight, there is a net inward flow of heat through the coat to the skin. Thus, resistance of the animal coat to enveromental heat-flow is of great importance to the control of BT.

Then the aim of the present study is to determine temperature gradients between body and surface areas with regard to air temperature and relative humidity to illustrate different ways of heat loss or gain (thermal exchange) during different seasons of the year and at varies body regions under Upper Egypt conditions.

MATERIALS AND METHODS

The present study lasted from autumn 1992 to next summer 1993 in Animal Production Experimental farm of the Faculty of Agriculture, Assiut University. As shown in Table (1) air temperature and relative humidity %(RH%) were recorded at the experimental day inside barn by using thermothermometers and hygrometer. Meteorological data (maximum and minimum) were also taken at the same time.

Ten adult lactating Jersey cows (age 4-5 years) were used in this study to determine temperature gradients between body and surface areas with regared to air temperature. Measurements were taken during four seasons of the year: autumn (October) 1992, winter (January & February) 1993, spring (April & May) 1993 and summer (July & August) 1993.

Table 1. Meteorological and actual data of air temperatures and relative humidity % (RH%) during the experimental period

Season	Air temperature (C^o)			RH %		
	Max.	Min.	In barn	Max.	min.	In barn
Autumn	36.6	14.2	34	70	17	41
Winter	19.4	03.8	12	93	39	66
Spring	35.7	15.2	32	53	17	18
Summer	39.9	19.8	32	59	18	23

For each animal, reading observations (rectal, skin and hair temperatures) were taken by telethermometer at noon two times each season with a 15 days intervals from six positions of body regions (neck, shoulder, mid-dorsal, mid-side, abdomen and flank).

Cows were housed in semishaded yard throughout the experimental period. At winter, animals were fed concentration mixture, rice straw and Bersem as a green fodder while in summer the same rations were offered except Darawa instead of Bersem. Salts blocks and water were free offered. Cows were hand milked twice daily at 7 a.m. and 4 p.m.

RESULTS AND DISCUSSION

Data presented in Table (2) and Figure (1) indicated that all temperature gradients i.e. (BT-ST), (BT-HT), (BT-AT), (ST-AT), (ST- HT) and (HT-AT) were the highest in winter while the lowest temperature gradients were observed between (BT-HT, 4.23) and (ST-HT, 0.62) in summer. On the other hand, the lowest gradients of (BT-ST),(BT-AT),(ST-AT) and (HT-AT) were observed in autumn. Negative gradient between (HT-AT, -0.22) was in autumn indicating that hair gained heat from the surrounding environment. These results indicated that to balance body temperature, heat was dissipated physically through radiation,convection and conduction in winter since a great difference in gradients were observed in such season. This way of heat dissipation was minimized in hot season whereas the animals less depended on physical ways and more depended on water evaporation,where the water comes to the skin surface through sensible and insensible perispiration of the water secreted by sweat glands. These results are in agreement with Darwish et al (1972). They found that Jersey cows raised at Upper Egypt conditions at successive AT of 10-40 C^{o}had the (BT- ST) gradients ranged from 6.1 to 2.4 C^o. the corresponding values for (ST-HT),(ST-AT)and (BT-AT) were 3.3-(-0.5),19.9-(-1.2) and 25.9-1.2 C^o respectively at 10 C^o and 40^o of air temperature. Similary, Shafie and Badreldin (1963) found that in dairy cattle and buffaloes and shorthorn bulles, the temperature gradient (BT- AT) declined linearly in all breeds in accordance with the increase in AT due to the increase in BT for each unit increase in AT. They added that the gradient (BT-ST) decreased in a slight slope due to the rapid increase in AT than BT. At 20 C^o the gradient (ST-HT) dropped directly to zero -0.5 C^o. They stated that 22-27 C^o air temperature is the critical range at which the control of BT through heat transportation,physical regulation, comes to an end. After this range heat regulation is achieved through reduction in metabolism and increase in water vaporization.

Data illustrated in Table (3) and Figure (2) indicated that gradients (BT-HT) and (BT-HT) were the highest at neck and mid- dorsal regions than other sites of the body. This is mainly due to the constant (BT) and lower (ST) at neck and mid-dorsal regions than other sites (Fig. 1), which in turn rise the gradients of neck and mid-dorsal regions. This incourage the dissipation of heat through radiation,convection and conduction more efficiently via neck and mid-dorsal than other sites of the body.

Table 2. Temperature gradients of Jersey cows at successive seasons of the year

Temp. gradients	Seasons of the year			
	Winter	Spring	Summer	Autumn
BT-ST	5.05	4.56	3.61	2.93
BT-HT	8.32	5.45	4.23	4.38
BT-AT	20.84	7.15	8.03	4.38
ST-AT	15.79	2.59	4.42	1.23
ST-HT	3.27	0.89	0.62	1.45
HT-AT	12.52	1.70	3.80	-0.22

BT-ST : Body temp.- Skin temp. ST-AT: Skin temp.- Air temp.
BT-HT : Body temp.- Hair temp. ST-HT : Skin temp. - Hair temp.
BT-AT : Body temp.- Air temp. HT-AT : Hair temp. - Air temp.

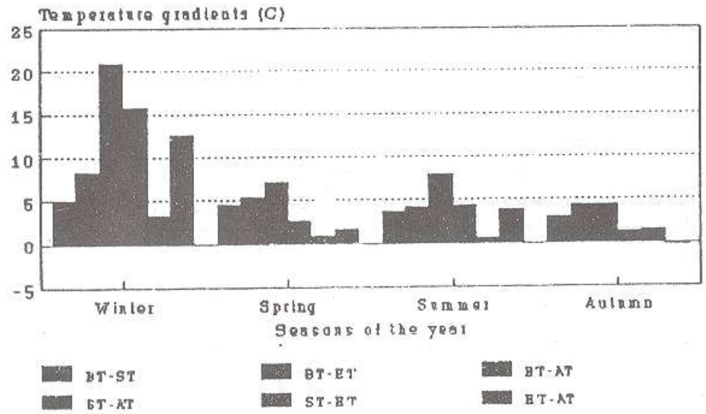

Fig. 1. Temperature gradients of Jersy cows at successive seasons of the years.

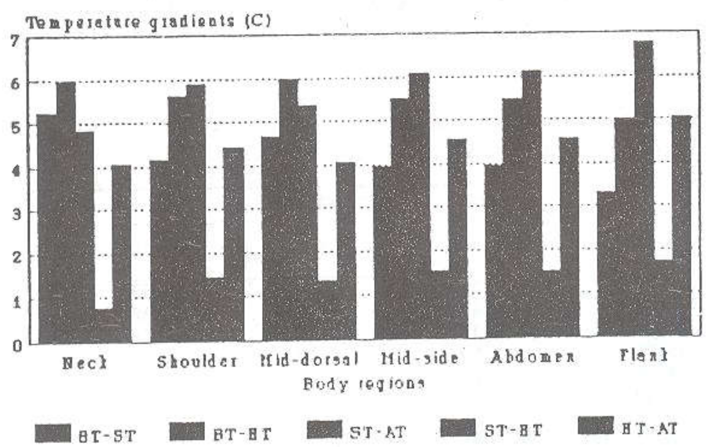

Fig. 2. Temperature gradients of Jersy cows at different body regions.

Reversly, when surface gradients (skin and hair) were concerned with air temperature and with each other data, Table (3) and Figure (2) showed that neck and mid-dorsal had the lowest values of gradients than other sites of the body. Thus, when concerning pathways of heat dissipation between BT and surface temperature, the neck and dorsal regions were efficent than other sites, but reverse direction was found when concerning surface temperature and air temperature.

Table 3. Temperature gradients of Jersey cows at different body regions

Temp. gradients	Body regions					
	Neck	Shoulder	Mid-dorsal	Mid-side	Abdomen	Flank
BT-ST	5.23	4.17	4.66	3.96	3.94	3.30
BT-HT	6.00	5.62	6.00	5.50	5.47	5.01
ST-AT	4.82	5.88	5.39	6.09	6.11	6.75
ST-HT	0.76	1.45	1.34	1.54	1.53	1.71
HT-AT	4.06	4.43	4.05	4.55	4.58	5.04

BT-ST : Body temp.- Skin temp ST-AT : Skin temp. - Air temp.
BT-HT : Body temp.- Hair temp. ST-HT : Skin temp. - Hair temp.
HT-AT : Hair temp. - Air temp.

These regions differences were previously confirmed when season's effect was taken into consideration. In winter (Table 4 and Fig. 3), mid-dorsal region had the highest (BT-ST) and (BT- HT) gradients while flank had the lowest gradients. The same direction was found in spring (Table 3 and Fig. 4). The marked decrease in gradients in both two seasons from mid-dorsal towards mid-side,abdomen and flank regions was due to the marked increase in ST and HT of the three later regions begining from mid-dorsal region while the lighest gradients at mid-dorsal were due to the lowest ST and HT at this site in both seasons.

The constant gradients of (BT-HT) in spring at neck,shoulder and dorsal regions was due to similar (HT) at these sites. In summer season, (BT-ST) and (BT-HT) gradients had nearly the same averages (Table 4 and Fig. 5) due to the less evident differences in surface temperature especially ST (Fig. 1) indicating the same region efficient dissipation at hot summer.

In autumn,ST and HT were the lowest at neck and mid-dorsal regions and the highest at flank one. This is reflected in increase gradients at neck and dorsal and decrease one at flank region (Table 4 and Figuer 6).

As shown in Table 4 and Figures 3,4,5 and 6 that gradients (ST-AT) were the highest in winter in all six body regions, whilst autumn was the lowest one. In all seasons, the gradients were the lowest at mid-dorsal region than any other sites. Such differences between gradients of (ST-AT) were less pronounced in summer indicating that physical or evaporatiove loss or heat dissipation was similar in all body regions at summer. The same direction was found for (ST-HT) gradients concerning the effect of seasons and body regions. The difference was the gradual decline in gradients from the neck towards the flank region at summer where the later had zero vlaue indicating that at flank region in summer (HT),(ST) and (AT) were equal. With regard to (HT-AT) gradients,neck,shoulder and mid-dorsal had the lowest gradients than mid-dorsal, abdomen and flank regions. Less marked differences in gradients were observed at autumn. It is interesting to note that at hot humid, autumn season' gradients had negative vlaues in all regions expect flank indicating that AT was higher than hair temperature. Thus animals absored heat through radiation,conduction and convection. All these results are in agreement with the findings of Shafie and Badreldine (1963), Darwish et al. (1972) and Finch (1986).

Previously, Kotby et al. (1977) studied rectal, skin and air temperatures interrelations in Friesian cattle under Kuwait conditions. They showed that skin temperature was more closely associated with rectal temperature than with air temperature. They also showed that the effect of rising air temperature and rising per cent relative humidity on skin temperature was almost equal in hyperthermic animals, (above 70°F air temperature for Friesian cattle.

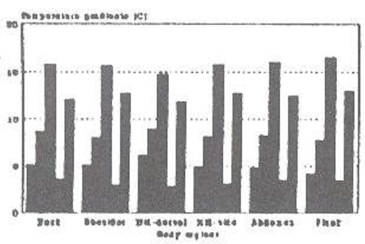

Fig. 3. Temperature gradients of Jersy cows at different body regions during winters.

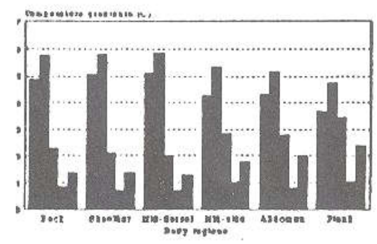

Fig. 4. Temperature gradients of Jersy cows at different body regions during spring.

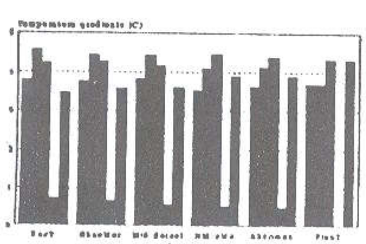

Fig. 5. Temperature gradients of Jersy cows at different body regions during summer.

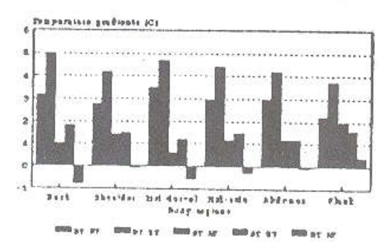

Fig. 6. Temperature gradients of Jersy cows at different body regions during autumn.

Table 4. Temperature gradients of Jersey cows at successive seasons and different body regions

Temp. gradients	Body regions					
	Neck	Shoulder	Mid-dorsal	Mid-side	Abdomen	Flank
			WINTER			
BT-ST	5.05	5.10	6.12	4.98	4.82	4.21
BT-HT	8.67	8.04	8.98	8.09	8.34	7.77
ST-AT	15.79	15.74	14.72	15.86	16.02	16.63
ST-HT	3.62	2.94	2.86	3.11	3.52	3.56
HT-AT	12.17	12.80	11.86	12.75	12.50	13.07
			SPRING			
BT-ST	4.88	5.05	5.13	4.30	4.32	3.70
BT-HT	5.77	5.79	5.85	5.36	5.15	4.76
ST-AT	2.27	2.10	2.02	2.85	2.83	3.45
ST-HT	0.89	0.74	0.72	1.06	0.83	1.06
HT-AT	1.38	1.36	1.30	1.79	2.00	2.39
			SUMMER			
BT-ST	3.80	3.76	3.85	3.56	3.63	3.71
BT-HT	4.55	4.44	4.43	4.11	4.14	3.71
ST-AT	4.23	4.27	4.18	4.47	4.40	4.32
ST-HT	0.75	0.68	0.58	0.55	0.51	0.00
HT-AT	3.48	3.59	3.60	3.92	3.89	4.32
			AUTUMN			
BT-ST	3.16	2.75	3.50	2.96	2.98	2.19
BT-HT	4.96	4.20	4.72	4.42	4.20	3.76
ST-AT	1.00	1.41	0.66	1.20	1.18	1.97
ST-HT	1.80	1.45	1.22	1.46	1.22	1.57
HT-AT	-0.80	-0.04	-0.56	-0.26	-0.04	+0.40

BT-ST : Body temp.- Skin temp
BT-HT : Body temp.- Hair temp.
HT-AT : Hair temp.- Air temp.
ST-AT : Skin temp. - Air temp.
ST-HT : Skin temp. - Hair temp.

CONCLUSION

It can be concluded from this investigate that temperature gradients exhibited an increase in winter and marked decrease in other three seasons of the year. This indicated that in cold months animal regulate heat without any stressful efforts via physical ways (radiation, convection and conduction). This ways ended gradually toward hot or hot humid months and replaced by evaporative cooling which achieved by the resperatory tract (increase the resperation rate) and through skin by sweating.

Observed low gradients (ST-AT, HT-AT and ST-HT) in hot seasons and high once in cold months reflected the important role of coat in thermo regulation by preservation heat inside bodies during winter and dissipate it during hot months.

Negative gradients (HT-AT, -0.22) achieved in autumn nearly in all body regions indicate that animal gained heat from the surrounding environment mainly via the adjacent hair which represent the target organ that affected firstly.

Thus, it is recommended that animals should be shower at least once a day and housed in a proper shed especially during hot humid months (Autumn) to avoide strain for these animals under Sub-tropical conditions.

REFERENCES

Darwish, M.Y., A.S. El-Sheikh, M.S. Barada and I.A. Salem, 1972. Studies on some environmental factors and their effects on heat regulation mechanism of Friesian cattle, Jersey and crosses cattle in Assiut zone. Assiut Journal of Agriculture Science. Vol 3 No (1). P. 77.

Finch, V.A., 1986. Body temperature in beef cattle: Its control and relevance to production in the tropics. J.Anim. Sc., 62:531-542.

Gebremedhin, K.G. 1985. Heat exchange between livestock and the environment. In: Stress physiologic in livestock Vol. I. Basic principls. by Yousef, M.K.(Edit.). Chapter, 3. pg. 15-33. CRC Press Inc. Boca Raton, Florida, (First Ed.).

Kotby, E.A., S.S. Khishin, A.A. Salman and A.M. El-Serafy, 1978. Physiological responses of Friesian cattle under arid enviroment. 2-Influence of source and age of animals on rectal, skin and air temperatures interrelations. Agric. Research Review, June, 13-18.

Shafie, M.M. and A.L. Badreldin, 1963. Skin temperature and temperature gradients in bovines. Proceedings of the 2nd Animal Production Conference, Cairo, 3-10, Vol. 11.

التدريج الحرارى فى الابقار الجرسى فى مصر العليا

محمد زينهم[1] -حسن دغش[2]

١- محطة بحوث الانتاج الحيوانى بملوى، معهد بحوث الانتاج الحيوانى، مركز البحوث الزراعية، الجيزة، مصر ، ٢- قسم الانتاج الحيوانى، كلية الزراعة، جامعة اسيوط، أسيوط ، مصر

تم استخدام درجات حرارة الجسم والجلد والشعر فى ستة مناطق مختلفة من الجسم لعشرة ابقار جرسى اصيلة (متوسط العمر ٤ - ٥ سنوات) وذلك لحساب التدرج الحرارى لهذه الابقار فى كلا من المواسم ومناطق الجسم المختلفة ٠اوضحت النتائج ان الفارق الحرارى بين حرارة الجسم وحرارة الجلد انخفض من الشتاء تجاه فصل اللخريف٠ وقد لوحظ نفس الاتجاه فى الفارق الحرارى بين حرارة الجسم وحرارة الجو٠ وقد لوحظ ايضا ان اقل فوارق حرارية كانت فى فصل الصيف بين حرارة الحسم وحرارة الشعر وكذلك بين حرارة الجلد وحرارة الشعر٠

عند الاخذ فى الاعتبار مناطق الجسم المختلفة فقد اظهرت مناطق الرقبة ووسط اعلى تدرج حرارى بين حرارة الجسم وحرارة الجلد وبين حرارة الجلد وحرارة الشعر عن اى مناطق اخرى فى جسم الحيوان بينما اظهرت منطقة الخاصرة اقل فوارق حرارية٠

من ناحية اخرى اوضح التداخل بين المواسم ومناطق الجسم المختلفة ان فصل الشتاء اظهر اعلى فوراق حرارية بين حرارة الجسم وحرارة الجلد عن اى مواسم وذلك فى مناطق الجسم المختلفة تحت الدراسة٠ لوحظ نفس فى الشتاء بالنسبة للفوارق الحرارية بين حرارة الجلد وحرارة الشعر وبين حرارة الجلد وحرارة الجو وايضا بين حرارة الشعر وحرارة الجو٠

اوضح فصل الصيف أقل فوارق حرارية بين حرارة الجسم وحرارة الشعر وبين حرارة الجلد وحرارة الشعر فى مناطق الجسم تحت الدراسة تقريبا بينما الفوراق الحرارية الاخرى بين حرارة الجسم وحرارة الجو وبين حرارة الجلد وحرارة الجو وأيضا بين حرارة الجلد وحرارة الشعر لهم اقل تدرج حرارى فى فصل الخريف عن باقى المواسم الاخرى٠

علاوة على ذلك اظهر الفارق الحرارى بين حرارة الشعر وحرارة الجو قيم سالبة فى فصل الخريف فى كل مناطق الجسم تحت الدراسة ما عدا الخاصرة موضحا ان الشعر امتص حرارته من البيئة المحيطه بـه فى فصل الخريف فى تلك المناطق٠

اوضحت هذه النتائج ان الفوارق الحراية كانت مرتفعة فى الشتاء وذلك فى مناطق الجسم المختلفة تحت الدراسة وعكس ذلك لوحظ فى الصيف والخريف موضحا انهاء الفقد الحرارى بالطرق الطبيعية اثناء المواسم الحارة٠