ENVIRONMENTAL FACTORS AFFECTING DAIRY CATTLE PRODUCTION AND REPRODUCTION IN THE ARID ZONES WITH SPECIAL REFERENCE TO KUWAIT CONDITIONS

BY

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THESIS

Submitted in partial fulfilment of the requirements for the degree of Doctor of Phylosophy

in

Animal Production

AIN SHAMS UNIVERSITY

Faculty of Agriculture

Cairo, A.R.E.

1974

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بسم الله الرحمن الرحيم

ACKNOWLEDGEMENT

Kind acknowledgement is expressed to Prof. Dr. S.S. Khishin, Head of Anim. Prod. Dept., Ain Shams Univ. for supervision, help and guidance throughout the course of this study.

Sincere appreciation should go to Dr. S. Kotby, Associate Prof., Anim. Physiology, of the same Dept. for suggestions, help and critical review of this manuscript.

The writer whishes to express his gratitude to Dr. S. Galal, to Dr. A.A. Younis, to Dr. A.M. Aboul Naga and to Dr. A. El-Sirafy and the rest of the staff members for the statistical analysis and help offered.

I wish to thank Mr. Jasim Katami and the rest of the board of directors of the Kuwait Dairy Co., and the authoroties of the Kuwait Dept. of Agric. who made this study feasible by providing facilities and for using the farm records to furnish a part of the data included in the study.

The help obtained from the author's colleages in the Dept. of Anim. Wealth and in the Kuwait Dairy Co. is very much appreciated, especially Mr. A. Homsi, Mr. I. Mujaij and Mr. S. Hussaini.

The author is greatly indebted to his wife, Mrs. M.A. Salman for encouragement and patience during the entire graduate program.

CONTENTS

INTRODUCTION

The uncontrolled fast increase in the world population, especially in developing countries, has resulted in increased demands for various nutrients with a consequent shortage mainly of animal protein.

The need for milk and dairy products is becoming extremely necessary to supply as many people as possible with at least the minimum quantity of protein of animal origin.

Exotic breeds of cattle in the tropical and subtropical regions, are impaired, or at least disturbed due to three main factors:

1. Unfavorable climatic conditions.
2. Different feeding and management practices.
3. Epidemic diseases and parasites.

Thus, deficient diets are known to exist especially in developing poor countries in such regions. It is important, therefore, to increase the supply of milk and milk products at an economical costing in those countries to improve the nutrition standard of the people. In a country like Kuwait whose income source comes out of the oil, the establishment and improvement of dairy industry is of vital importance.

A major problem facing the dairy industry in Kuwait is the unfavorable climate, another problem is the insufficient fresh green food for cows throughout a certain period of the year.

Since the importation of various dairy breeds of cattle such as Friesians, Red Danish and Jerseys, in the early sixties, no study has been made on the performance of those breeds under the set of circumstances prevailing in this country.

The climate of Kuwait is summarized in Table 1 and Fig. 1.

An absolute maximum air temperature of 120°F is sometimes reached during July and August, and an absolute minimum air temperature of 27°F is reached in January.

An average maximum relative humidity of 90 % is reached in January and an average minimum relative humidity of 13 % exists in June.

An average maximum solar radiation intensity of 780 mw/cm^2 of earth surface is reached in June, as compared to an average minimum of 350 mw/cm^2 of earth surface in January. The duration of sunshine is maximum in August (10.8 hrs./day) and minimum in December (6.9hrs./day).

Sometimes a wind speed could reach 18 miles/hour, during windy seasons. The main wind direction is very often north, northwest and northeast in June through August.

Rainfall season, however, extends from November through February, although, some rain may fall in April or even in May in some years (1961, 1962 and 1963). Rainfall in January and February may reach a maximum average of 27-24 mm, although a minimum average rainfall of 0.2-3.4 mm may exist in these same months.

Table 1: Air Temperature and Relative Humidity % Mean Values of 1961 - 1970. From Meteorological Records.

Month	Mean Air Temp. °F				Mean R.H. %			
	Max. A	Min. B	Differ. A-B	Ave.	Max. A	Min. B	Differ. A-B	Ave.
January	68	40	28	58	90	43	47	63
February	67	43	24	56	80	30	50	54
March	78	52	26	65	75	25	50	50
April	88	62	26	75	70	23	47	45
May	98	75	23	86	60	19	41	40
June	107	78	29	92	40	13	27	28
July	110	78	32	97	45	15	30	29
August	109	77	32	95	49	17	32	33
September	105	70	35	90	50	19	31	34
October	95	65	30	80	65	25	40	42
November	82	55	27	69	70	30	40	51
December	65	42	23	56	75	40	35	60

Approximated values to eliminate decimal numbers.

REVIEW OF LITERATURE

Effects of Environmental Temperatures on Body Temperature, Respiration and Pulse Rates.

1. Normal Body Temperature of Cattle

Various investigators accept 101.0°F (38.3°C) as the normal rectal temperature for almost all breeds of cattle (Regan and Richardson, 1938; Brody, 1945; Gaalas, 1945; Rieck and Lee, 1948 a and b; Kibler and Brody, 1949 and 1950; Worstell and Brody, 1953 and McDowell, 1958). Slight deviations observed, however, were due to age, stage of lactation, level of nutrition and reproductive stage (McDowell, 1958).

As for Holstein cows, normal rectal temperature ranged from 100.0° to 101.2°F. (Kibler and Brody, 1949 and 1950).

As for different Indian breeds fed a balanced ration, normal rectal temperature was 101.1 - 101.3°F. (Bhattacharya, et al., 1965).

2. Normal Respiration Rate of Cattle

[illegible] respiration rate of cattle was shown by various workers to range between 20-30 respirations per minute at air temperatures of 50° to 60°F. (10.0 - 15.6°C), (Rieck and Lee, 1948 a and b; Kibler and Brody, 1949, 1950 b and 1951; Findlay, 1950 and Benezra, 1954).

In a more recent study by Kibler (1962), the respiration rates were 27, 32 and 22 respirations per minute for Brown Swiss, Holstein and Jersey calves respectively, at 50°F. environmental temperature and 64 % relative humidity.

The factors that caused great variations in the normal rate of respiration in cattle included sex, body size, age, exercise, excitement, pregnancy and degree of filling of the digestive tract particularly the rumen (Dukes, 1955).

3. Normal Pulse Rate of Cattle

Various reports showed that the normal pulse rate of cattle varies greatly. Badreldin, *et al.* (1951) reported yearly means of 63.8, 62.0 and 61.4 beats per minute for Shorthorn, Jersey and Egyptian native cattle respectively. However, Shafie (1958), reported pulse rates of 67.8 ± 1.4 and 56.4 ± 0.8 beats per minute for Shorthorn and Egyptian native adult cattle, respectively. It would be noticed that animals utilized in these two reports previously mentioned were located in Giza district at the borders of Cairo to the south. Salem (1966), reported pulse rates of 76.7 ± 6.9 and 71.4 ± 7.4 beats per minute for Friesian and Jersey cows, respectively. Animals used in that study by Salem (1966) were located at Assiut, Upper Egypt.

Earlier, Kibler and Brody (1949 and 1951) reported averages for pulse rate ranging between 57.0 - 64.3 for Brown Swiss, 56.4 - 63.8 for Holstein, 63.6 - 65.9 for Jersey and 61.3 - 67.0 beats per minute for Brahman cows. These averages were obtained for animals under air temperature range 40° - 60° F., considered as the thermo-neutrality zone. These same authors reported higher values for young growing heifers. It is worth noting that the work by Kibler and Brody (1949 and 1951) was carried out in the climatic chambers.

Alcaide (1950); Mensalvase and Rivera (1951) and Mullick and Kehar (1959) showed that the pulse rate of Phillipine and Indian native cattle ranged between 51-54 beats per minute. Bhattacharya (1965), reported pulse rates ranging between 66-68 for heifers and young bulls of different Indian breeds.

Recently, Fathalla (1972) reported average pulse rates ranging between 66.4 - 68.2 for Friesians, 64.2 - 73.0 for Egyptian native cattle and 62.0-78.3 beats per minute for Friesian crosses and Hereford crosses at El-Wady El-Gedid (The New Valley) project in Egypt.

Factors Affecting Body Temperature, Respiration and Pulse Rates of Cattle.

1. Atmospheric temperatures

a. Effects on body temperature

Effects of atmospheric temperatures on the physiological reactions in European - evolved breeds of cattle, Indian - evolved breeds, and crosses, have been studied by numerous investigators. Almost all results obtained came into agreement that increasing air temperatures will tend to rise the body temperature and increase the rate of respiratory activities, but to decrease the pulse rate. Indian-evolved breeds were more heat tolerant than European-evolved breeds, although different levels of heat tolerance were shown among the different breeds of European ancestry.

When the animal is maintaining a constant body temperature within a given range of air temperatures and when that animal is functioning at the proper level of physiological efficiency at that given range of air temperatures, that range is known as the "comfort zone", (Rhoad, 1944). Worstell and Brody, (1953), showed that it lies between the freezing point and 60°F. These same authors indicated that all breeds of cattle were readily adaptable to cold. The exact range of comfort zone depends mainly on the level of the animal's production and its size. The higher the level of production and the larger the animal the greater is the cold tolerance. Brody, (1956), and Findlay, (1958), reported that the comfort zone varies from 30° to 60°F. (1 to 16°C.) air temperature in the case of typical temperate type cattle and from 50° to 80°F. (10 to 27°C) in the case of typical tropical type cattle. As the air temperature is elevated above these levels, the thermoregulatory mechanisms are activated with the manifestation of increased respiration and vaporization rates.

Controlled temperature studies in the laboratory showed that the body temperature of cattle was normal and was maintained constant at environmental temperatures below 70°F. Increasing air temperature above the critical level 70° - 80°F. (21.1 - 26.6°C), caused a rise in rectal temperature (Regan and Richardson, 1938; Kibler and Brody, 1949, 1950 b and 1951; Worstell and Brody, 1953; Halan, _et al_., 1963, and Haines and Koger, 1964).

Of particular importance was that study by Kibler and Brody (1950), which demonstrated for the first time that the critical air temperature for the Indian - evolved Brahman cows was not 70° to 80°F., but was 90° to 95°F. That the critical air temperature was relatively high, 90°F. (32°C) for tropical type cattle was further confirmed by Worstell and Brody (1953). Brody (1956), however, indicated that the critical air temperatures were 80°F (27°C) for European - evolved cattle and 95°F (35°C) for Indian - evolved cattle. That the critical air temperature differs with age was shown by Kibler and Brody (1951), and that it differs with different breeds of similar origin (temperate type cattle) was also shown by Worstell and Brody (1953). When air temperature rises above these critical levels, the thermoregulatory mechanisms start to fail, leading to an abrupt rise in rectal temperature with consequent manifestation of "heat stress" symptoms. Under such conditions the heat stressed animal shows declining feed intake, decreasing productive processes such as growth and milk production in lactating animals with changes in milk composition (Johnson, 1965).

On the other hand, Kibler and Brody (1950) demonstrated that gradually decreasing air temperature from 50° to 5°F. did not cause any significant change in rectal temperature of Jersey and Holstein cows.

Studies under field conditions and observations on variations of body temperature in response to environmental temperatures revealed similar results. Field studies, also, pointed out the deleterious combined effect of different climatic factors such as humidity, solar radiation intensity and air movement, which add to the influence of the atmospheric temperature on body temperature of cattle (Bonsma, et al., 1940; Seath and Miller, 1946; Gaalas, 1947; Badreldin, et al., 1951; Branton, et al., 1953; Quazi and Shrode, 1954; Shafie, 1958; Hamoud, 1970 and Fathalla, 1972).

That a positive correlation exists between air temperature and body temperature of cattle, the magnitude of which differs with the breed, was shown as early as 1946, 1947 by Seath and Miller. They obtained a correlation coefficient of 0.74 and 0.71 between air temperature and body temperature in Holsteins and Jerseys, respectively. It was found that the average body temperature of Holsteins was 0.8 % higher than Jerseys at an average air temperature of 85°F. The definite positive relationship between air temperature and the body temperature of different breeds of cattle has been confirmed by numerous investigations carried out under field conditions by Gaalas (1945 and 1947); Seath and Miller (1946 and 1947); Badreldin, et al. (1951); Mullick and Kehar (1959); Haines and Koger (1964) and Shafie, et al. (1969), or in the climatic chambers by Lee and Phillips (1948), Rieck and Lee (1948a and b), Kibler and Brody (1950 and 1955), McDowell, et al. (1955), Cartwright (1955), and Bianca (1963).

Although a nonsignificant correlation between air temperature and daily body temperature was reported by Alim and Ahmed (1956) and also by Bhattacharya (1965), statistically significant correlation coefficients between air temperature and rectal temperature of different breeds of cattle were reported by Seath and Miller (1946 and 1947).