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ACTIVITY OF THE SEBACEOUS GLANDS OF BOVINES IN HOT CLIMATES

By

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This work was carried out to study the rate of sebum secretion, species, breed, age and seasonal difference, and the effect of direct solar radiation on sebum secretion. A total of 23 buffaloes, 20 Egyptian cattles, 24 Shrothrons and 21 Friesians, of different ages were used in this study. Sebum collection was carried out by rubbing a definite area of skin surface with petroleum ether which is collected, filtered and evaporated to give the sebum.

The following results were obtained :

1. The Buffalo was the highest species in sebum secretion(111mg/m².) in cattle breeds the sebum secretion was 40, 29, 25 mg/m². in Friesian, Shorthorn, and Egyptian cattle respectively. Species and breed differences are highly significant.

2. The season affected significantly the sebum secretion in both buffaloes and cattle breeds. The secretion increased in Winter than in Summer, the increase was higher in Shorthorn and Friesian than in Egyptian cattle.

3. The sebum secretion was higher in calves than in adults, however this age difference was not significant.

4. Exposure to direct solar radiation induced a slight increase in sebum secretion in cattle, however the Friesian was the mostly affected breed, but the buffaloes reduced its secretion under the exposure conditions.

5. The sebum secretion in cattle reached its stable amount directly after 2 hours from removing the sebum cover of skin by solvents while the buffaloes recorded the peak amount of secretion at one day period. The interval of time between determinations does not affect significantly the rate of sebum secretion.

6. The sebum amount per m² of cattle skin was related to the total volume of glandular tissue per unit area of skin. The buffaloes had the highest sebum level while they possessed only a very small glandular volume compared to cattle. This was attributed to the rich supply of the glands by blood vessels and capillaries.

The importation of the temperate cattle breeds to the tropical and sub tropical localities have drawn the attention of the research workers to the interelationship between the climatic factors and the morphological and physiological characteristics of the animals. Extensive work has been carried out all over the world to estimate the significance of each physiological proces in heat regulation and adaptation of the animal to hot climates. Of course morphological characteristics of tkin and hair coat got the first attention, many publications are available in this respect (Bardeldin, and Ghany 1952, Carter & Doubing, 1954, Doubing, 1955, Hafez etal, 1955 a & b, Doubing, 1958, and Doubing, 1959 a & b).

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The skin microanatomy and sweat glands and capillary distrebution in skin were studied in different breeds (Yamane and One, 1936, Findlay & Yang, 1948, Findlay *et al.*, 1949, Findlay & Yang, 1950, Groodall & Yang, 1954 and Nay, 1959) and and related to sum activity and water evaporation from skin surface, (Hafez & Shafie, 1954). The sebaceous glands of farm animals hardly drawn the attention of the workers and no attempt has been done to relate its activity to climatic and invironmental conditions. The study of sebaceous glands in human skin had a scope other than relation to climate, however it offered good technical consideration to the different methods of estimating the measurements and the activity of these glands.

The rate of sebum secretion was studied in humans by measuring the quantity of lipids on skin surface 45.18+2.73 ug./sq.cm. on the forearm (Jones *et al.*, 1951). When the sebum is removed from the skin surface, it is replaced directly by a rapid rate which decreases sharply to the end (Tsuchiya and Akira, 1962). The amount of sebum over a given area of skin is constant and the secretion stops when a certain level is reached, and starts again when the amaunt falls below this level (Schur and Goldfarb, 1927). The pressure and viscosity of the secreted sebum offers an increasing resistance to further output, to bring the secretion to a stop, and the glands continue secreting as long as its energy can overcome the resistance of the overlying sebum layer, (Emanue, 1938). Surface lipids of the forehead return to the normal level after 2 to 3 hours from its removal (Tsuchiya and Akira, 1962). The sebum layer was rebuilt in about 3 - 4 hours (Enderlin *et al.*, 1954). The sebum was reaccumulated at such a rate that the pre-wash level was reached in approximately one hour (Lorenz *et al.*, 1952). A greater quantity of lipoids is collectable during a given time interval with repeated removals as compared to single removale (Kligman and Walter, 1958). The time needed for rebuilding the sebum layer was practically the same which other chemicals were used for the removal of sebum (Enderlin *et al.*, 1954). The amount of sebum during 4 hours was 163 and 164 micrograms per sq.cm., after washing the skin with soap and with a detergent respectively, the average secretion value during the preceding two weeks control period was some what low, 152 micrograms per sq.cm. however the difference was not significant (Kirk and Efferose, 1953).

Many factors affect the rate of sebum secretion in humns, especially air temperature, age and skin regions, the other factors such as sex, period of testing, method of testing and the examined area induce minor variations. Air temperature is the most important factor in determining the sebum level because of changes produced in the viscosity of sebum, the sebum produ;tion capacity was the greatest at 40°C., less at 20°C., and the lowest at 10°C., (Von Zehender and Dunner, 1946). Most of the workers stated that the sebum secretion is greatly affected by age. The sebum secretion was very small in children under 13 years old, while fifteen years old showed remarkable increase, the greatest values were obtained at 20 to 35 years. Old, after which it decreased in adults about 40 years of age (Tsuchiya and Akira, 1962). The osmic acid test for sebum secretion was negative until puberty, Strongly positive in adults and weak in the aged (Enderlin *et al.*, 1954).

The anthracene paper test, was positive in 95-100% of cases between 16 - 50 years old and less often positive after 50 years of age (Brun et al, 1953). On the contrary Inversen *et al.* (1953) found no significant correlation between age and lipid levels on the forehea.

The different methods used for measuring the sebum secretion in humans varied in its applicability and accuracy, it also differed according to the organ to be tested and the sim of stimation. Lorenz *et al.* (1952) collected sebum by pressing the endof small glass rod against clean skin surface and measuring the area of the fat film spreaded in a monomolecular layer of oil. This method does not measure the absolute amount of sebum produced by the skin, but may be used to detect changes in the quantity. The methods of placing a filter paper ompregnatedovr not with a solvent on the examined area of the skin, was widely used. Jones *et al.* (1951) placed a fat free filter paper on the skin and then the paper was extracted with the petroleum ether. Burn and Mayer (1951) used filter papers impregnated with anthracene solution before application to the tested area, when it was exposed to wood's light fater application it showed a bright blue fluorescence except on the spots in filterated with sebum. Enderlin *et al.* (1945) applied filter ppaers impregnated with osmic acid to test the sebum newly exerted at the orifices of hair. The advantages of these filter paper methods were simple technique, short duration, small testing area, possibility of studying the amount and distribution of lipids on the skin itself and the absence of irritating effect induced by the solvent methods. (Tsuchiya and Akira, 1962). Robin and Joseph; (1953) applied the osmic acid vapour to skin areas after removal of the previous fat from those areas by cleaning with ether. The formed sebum was stained and appeared as black dots of varying sizes rated on a scale from 0-4 +. Other authors applied fifferent solvents by several ways to the measured skin area. Emanuel (1936) used small containers fastened to the skin, in which a mixture of alcohol and ether can be held directly in contact with the area to be tested for a fixed time. Kirk (1948) and Kirk and Efferose (1953) used ethyl ether for collecting skin lipids.

Ricketts et al (1948 and 1951) and Mackenna et al (1950 and 1952) immersed the tested organ (limps) in acetone for a fixed time. A scrubbing method was used by Jones *et al.* (1951), where peices of fat-free cotton or gauze were soaked in solvent, rubbed on a definite area of skin, and extracted to obtaine the fat.

This work was carried out to investigate the seasonal and age difference in the rate sebum secretion in Egyptian buffaloes and cattle and in imported temperate zones cattle breeds, Frisian and Dairy Shorthorn. Also the effect of direct solar radiation on the activity of sebum secretion was tested.

Material and Methods

This work was carried out in the Animal Breeding Department; Faculty of Agriculture, Cairo University, U.A.R.

The experimental period lasted eight months starting from June 1962 up to February 1963. The work comprised the study of the effect of seasonal variation, age difference and direct solar radiation on the sebum secretion in buffaloes, Egyptian cattle, Dairy Shorthorn and Friesin cattle breeds.

The activity of the sebaceous glands, the rate of sebum secretion was also studied in the same breeds.

The seasonal effect on the amount of sebum was studied monthly in 18 months old five animals of each breed from both right and left sieds. The correspinding value of air temperature was recorded.

The study of age difference was carried out on 5 adult, 5 eighteen months old and 5 six months old animals of each breed. The sebum was collected from each animal monthly in Summer (July and August) and in Winter (January and February).

The effect of solar radiation on sebum secretion was estimated on 7 adults animals from each breed. Animals were exposed to sun for two hours after washing the determined area of skin by petroleum ether, the sebum secreted during the exposure period was measured. A similar number of control animals were treated similarly, except that they were kept under shade during the period of sun exposure of the other group.

The activity of the sebaceous glands was estimated by measuring the sebum secreted after period of 2 hours, one day, 3 days, one week and one month. Four adult individuals of each breed were used for one period, the test repeated five time for each individual.

The sebum was collected from a definite area of the animal side 60×60 cm. in case of cattle and 60×30 cm. for buffaloes and Friesian calves of 6 months olds. The area under test was cleaned by petroleum ether B.P. 80 - 110°C. A piece of a fat-free cotton held in a foreceps was soaked in the petroleum ether and rubbed twice on the determined area of the skin, first vertically and then horizontally. Every 60×30 cm. of the tested area was treated by 80 ml. of the solvent by repeated soaking of the cotton piece and rubbing till the solvent was finished.

The cotton piece was then finished in petroleum ether over night in a collecting specimen tube to dissolve the fat obtained in it. The petroleum ether was then transferred quantitatively to a weighing glass through a filter paper to get rid of dust and foreign particles. The collecting tube and the cotton piece were washed with pure petroleum ether several times up to 50 ml., each time the cotton piece is rinsed and squeezed by a spatula to expel the absorbed solvent. The petroleum ether was evaporated in an oven adjusted at 40°C., after then the oven temperature was raised to 95°C. for 3 hours. The weighing glass was taken off from the oven cooled in a dessicator, and weighed on a sensitive balance. The weight of fat was determined and calculated as mg. per m². of the animal surface. Statistical analysis were carried out according to Snedecor (1965).

Results

Species, Breed and Month Differences in Sebum Secretion :

Sebum secretion varied according to species, breed and month, (table 1 and Fig. 1 and 2). It is higher in buffaloes (111mg/m².), than in cattle breeds, (32 mg/m².) Also there was marked breed differences between cattle

breeds, the Friesians had the highest value than both shorthorn and Egyptian cattle, 40, 29 and 25 mg/m^2. respectively. The breed differences were hgihly significant (Tables 1 and 2).

The monthly variations showed a significant effect on sebum secretion (Tables 1 and 2). The highest values in both buffaloes and cattle breeds occured in the winter months especially February when the average of air temperature was the lowest, 13.8°C.

The difference between the right and left sides in all animals was not significant (Tables 1 and 2).

The individual variations were more pronounced in the case of buffaloes than in cattle breeds evidenced by the value of standard errors in table (1).

Age Differences in Sebum Secretion:

The 18 months old buffaloes showed the highest value of sebum amount per unit area of skin, the least secretion value was that of the 6 months old animals (Table 3 and Fig 3). In cattle breeds, the highest secretion was of 6 months old calves. Then the 18 months old animals, the least secretion value was that of the adult animals except in Egyptian cattle where the sebum secretion value was that of the adult animals except in Egyptian cattle where the sebum secretion was the same in the adult animals and the animals of 18 months old. The age difference in sebum secretion was very clear in Friesians than in other species and breeds (table 3 and Fig. 3). However, the differences were significant only between the 6 months old calves and other ages in the Friesians, while in the other species and breeds there was no significant difference between ages (Tables 3 and 4). This trend of age difference was more regular and clear durin Winter season than in summer (Table 3) and the effect of month was highly significant ((Table 4).

Effect of Solar Radiation on Sebum Secretion:

Animals exposed to sun showed slight difference in sebum secretion than shaded animals. The Friesians were the mostly affected breeds, while buffaloes showed a special reaction by reducing the sebum secretion under the exposure conditions (Table 5 and Fig. 4). However, the difference between exposed and shaded animals was not significant Table 5).

Rate of Sebum Secretion:

In general, the sebum secretion in cattle showed the highest value after 2 hours from removing the sebum cover of sikn by solvents. In case of buffaloes, the peak is retarted till one day (Table 6 and Fig 5). It is clear that the shorthorns, showed a fairly stable value of sebum secretion whatever long is the period. Both Friesians and Egyptian cattle showed less stability in this respect. At longer intervals the sebum amount decreased gradually from that peak value. However the differences between periods were not significant except in buffaloes (Table 7).

TABLE 1.—THE SEBUM SECRETION FROM THE RIGHT AND LEFT SIDES OF BUFFALOES AND CATTLE IN SUCCESSIVE MONTHS

Month	AIR temp. °C.	Sebum amount mg./m². of skin								
		Buffaloes		Cattle Breeds						
				Egyptian		Shorthorn		Friesian		
		Right	Left	Right	Left	Right	Left	Right	Left	Average
July	27.1	143±40	97±29	18±2	13±4	7±1	10±2	14±1	18±1	13
Aug.	27.6	72±43	80±29	13±1	17±2	22±5	29±3	28±4	32±2	23
Sept.	28.0	113±10	88±12	30±8	39±12	20±2	19±3	41±4	51±8	33
Oct.	26.3	131±7	78±8	22±1	23±3	21±3	39±9	33±8	38±4	29
Nov.	24.3	68±1	114±38	22±4	24±10	39±10	39±9	52±6	45±6	36
Dece.	20.8	117±13	128±24	21±3	37±3	27±6	34±7	48±4	53±10	37
Jan.	14.4	144±50	119±23	26±2	29±4	38±8	44±10	32±7	39±9	34
Feb.	13.8	124±30	153±35	29±3	48±15	43±7	40±5	41±1	78±14	47
Average .		111		25		29		40		

Least significant differences (from table 2).
Between species and breeds . . . . . 13 mg./m².
Between months . . . . . 18 mg./m².
Between sides is not significant.

TABLE 2.—TEST OF SIGNIFICANCE OF DIFFERENCE IN SEBUM SECRETION BETWEEN SPECIES, BREED, MONTH AND ANIMAL SIDE

Source of variation	Degrees of freedom	Sum squares	Mean squares	F
Total	63	94256	—	—
Species & Breed	3	76399	25466	77.50
Month	7	6328	904	2.75
Side	1	138	138	0.42
Error	52	1708	329	

Species & Breed : significant at 99%
Month : significant at 95%
Side : not significant.

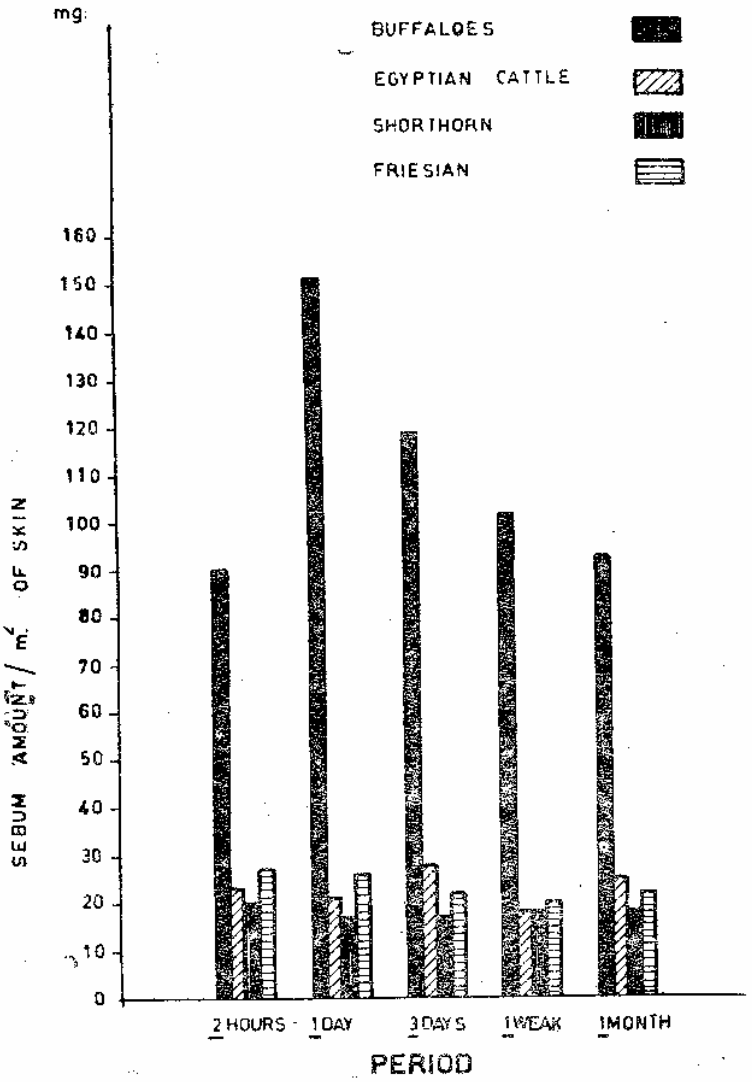

FIG. 1.— Sebum amount in buffaloes and cattle after different periods from skin washing.

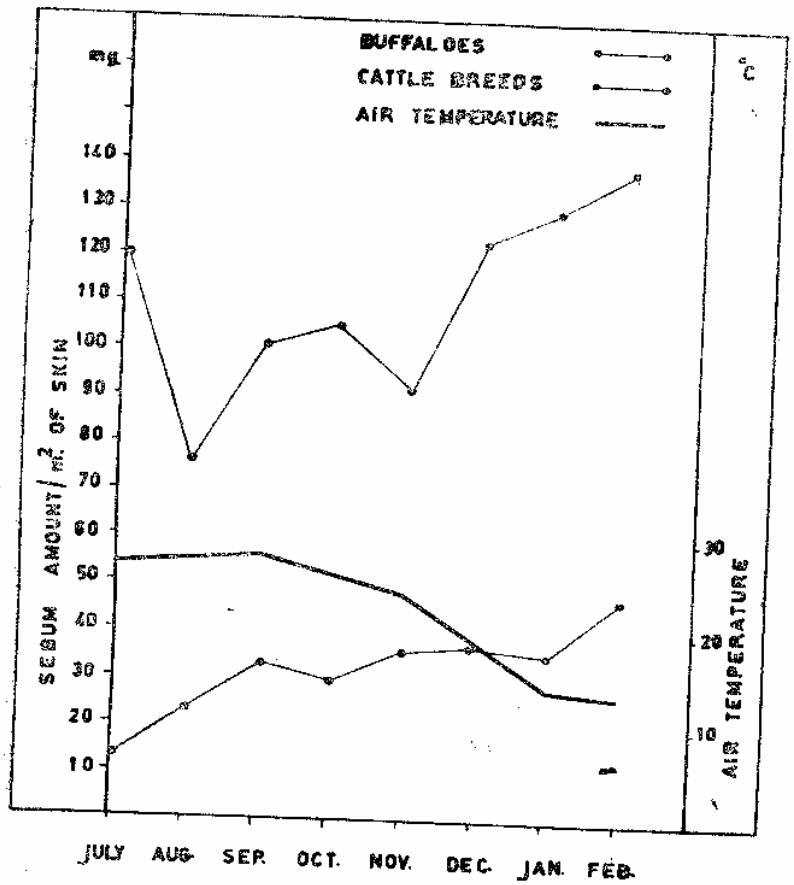

FIG. 2.— Seasonal variation and species difference in sebum secretion between buffaloes and cattles.

TABLE 3.—AGE DIFFERENCES IN SEBUM SECRETION IN BUFFALOES AND CATTLE IN SUMMER AND WINTER MONTHS

Age Month	Sebum amount mg./m². of skin											
	Buffaloes			Cattle Breeds								
				Egyptian			Shorthorn			Friesian		
	Adult	18	6	Adult	18	6	Adult	18	6	Adult	18	6
July	75±22	97±29	70±14	34±3	13±4	23±12	13±2	10±2	15±4	14±3	18±1	21±6
August	67±13	80±29	152±22	21±3	17±2	49±5	22±6	29±3	34±4	25±3	32±2	103±14
January	127±20	119±23	94±11	24±3	29±4	30±4	37±4	44±10	44±10	47±3	39±9	54±3
February	141±26	153±35	94±22	32±5	48±15	42±2	42±2	40±5	42±3	67±7	78±14	71±1
Summer Average	71	86	101	27	15	44	20	18	24	19	25	62
Winter Average	134	137	94	28	38	36	40	42	43	53	60	63

Least significant difference (from table 4).

Between ages . . . . . 13 mg./m².

Between breeds . . . . . 15 mg./m².

Between months . . . . . 15 mg./m².

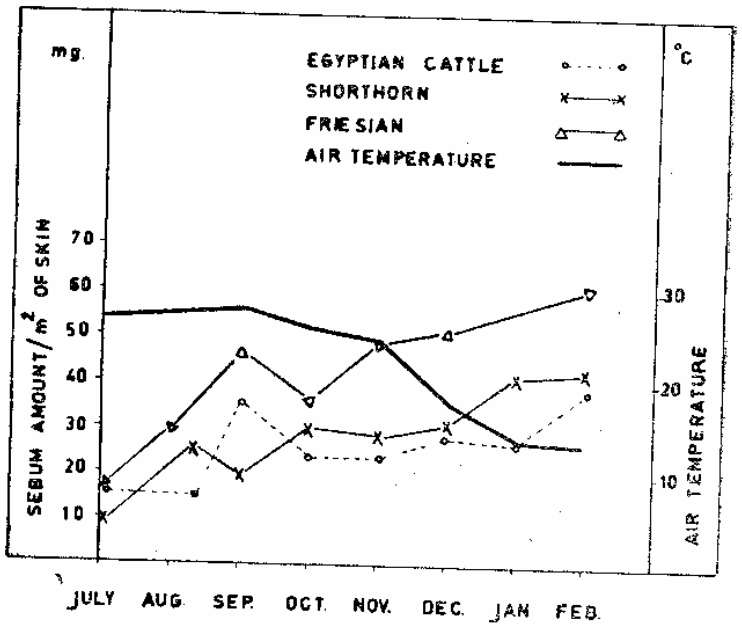

FIG. 3.— Seasonal variation and breed difference in sebum secretion between cattle breeds.

TABLE 4.—TEST OF SINGIFICANCE FOR THE EFFECT OF AGE, MONTH AND BREED ON THE SEBUM SECRETION IN BUFFALOES AND CATTLE

Source of variation	Degrees of freedom	Sum squares	Means squares	F
Total	47	68537	—	—
Breed.	3	45723	15241	44.049
Age	2	698	349	1.009
Month	3	8621	2874	8.306
Error	39	13495	346	5

Breed : significant at 99%
Month : significant at 95%
Age : significant only between 6 months and other ages in Friesian cattle (L.S.D. 13).

TABLE 5.—EFFECT OF DIRECT SOLAR RADIATION ON SEBUM SECRETION IN BUFFALOES AND CATTLES

Breed	Sebum amount mg/m² of skin							
	Buffaloes		Cattle Breeds					
			Egyptian		Shorthorn		Friesian	
	*E	**S	E	S	E	S	E	S
1	81	124	46	31	21	25	26	19
2	91	70	40	27	32	23	47	21
3	97	118	28	52	18	21	38	43
4	113	118	33	23	31	25	38	23
5	162	118	36	32	24	40	1–	18
6	82	113	32	29	44	26	22	21
7	44	78	31	28	24	26	—	—
Average . .	96±14	106±8	35±2	31±4	28±3	27±2	31±5	24±4
Diff. E-S	10		3		1		7	
% of variation .	9		10		4		30	
Test of significance of radiation effect "t" value	0.619		0.810		.284		1.141	

* exposed to direct solar rays.

** Shaded.

"t" Values are not significant in all breeds.

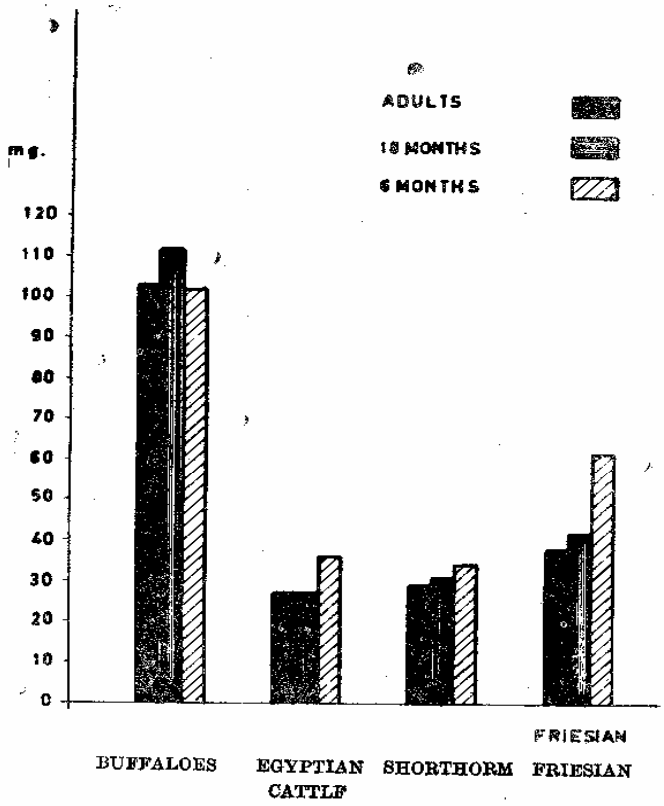

FIG. 4.— Age differences in sebum secretion in buffaloes and cattle.

TABLE 6.—ACTIVITY OF SEB A CEOWS GLANDS IN BUFFALOES AND CATTLE THE SEBUM AMOUNT AFTER DIFFERENT PERIODS FROM SKIN WASHING

Period of sebum sec retion	Sebum amount mg/m²				
	Buffaloes	Cattle Breeds			
		Egyptian	Shorthbon	Friesian	Average
2 hours	90±5	23±3	20±2	27±2	23
1 day	152±12	21±9	17±1	26±3	21
3 days	119±16	28±2	17±2	22±1	22
1 week	102±9	18±8	18±1	20±4	19
1 month	93±53	25±13	18±10	22±12	22

Least significant differences (from table 7).
Between periods 20 mg./m².
Between breeds 12 mg./m².

TABLE 7.—TEST OF SIGNIFICANCE FOR THE EFFECT OF PERIODS OF SECRETION ON THE AMOUNT OF SEBUM IN BUFFALOES AND CATTLE

Source of variation	Degree of freedom	Sum Squares	Means Squares	F
Total	19	32976	—	—
Breed	3	30286	10095	59.73
Period	4	651	163	00.96
Error	12	2039	169	—

Breed : significant at 99%
Period : significant only in buffaloes (L.S.D. table 6).

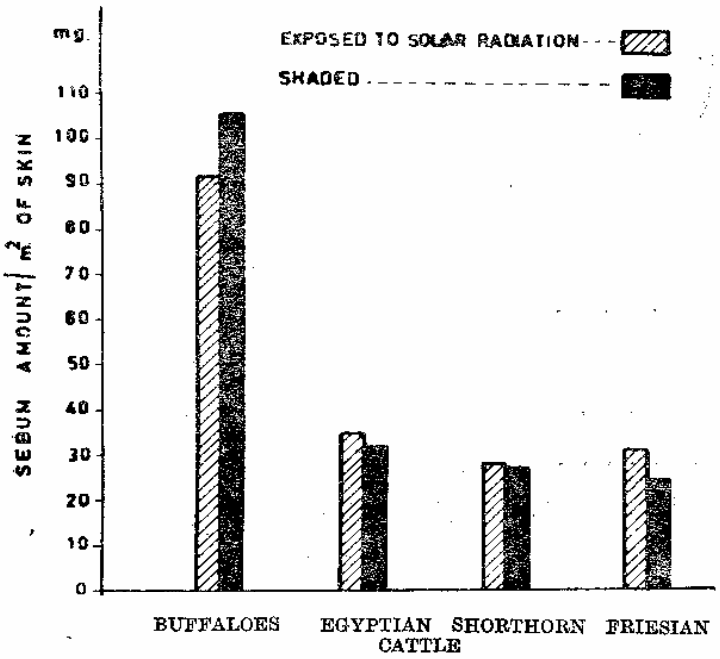

FIG. 5.— Effect of direct solar radiation on sebum secretion in buffaloes and cattle.

Discussion

Buffaloes stand away from the cattle breeds concerning the high activity of its sebaceous glands. This is an interesting characteristic in these animals which are fond of swimming and wallowing. Since buffaloes are semi-aquatic animals their sebaceous glands represent to a certain extent the oil glands of the aquatic animals. The lily sebum covering of the body hinders water absorption from skin surface consequently protecting the body from any harmfull or irritative effect of the water solutes. This function is backed by the thick cornium stratum in buffaloes (Hafez *et al* 1955b).

On the other hand this oily sebum layer, Which is so thick in buffaloes in comparison to cattle, exerts a deleterious effect on the animals as it hinders water perispiration and evaporation from the internal body tissues to the outside. Therefore heat dissipation in these animals would be seriously

hampered unless it aquires a special behaviour to moisten its surface from outside water such as by swimming and wallowing. In this respect Freeborn *et al* (1934) proved that spraying cows lightly with oil induced an increase in their body temperature above the normal level.

The difference between cattle breeds in sebum secretion activity seem to be a natural adaptation to local environments, as the sub-tropical Egyptian cattle showed the lowest activity while the temperate zone cattle breed showed the highest activity.

The increase in sebum secretion in all breeds during winter season is another adaptational reaction for body heat preservation. This is in good agreement with the finidings of Dempsey (1946) who suggested that the contraction of the pili muscle due to cold sensation sqeezes the sebaceous gland which is laying between the muscle and the hair. Follicle, this pressure on the gland would expell more sebum to the skin surface. It is interesting that at the same time the muscle contraction blocks the sweat gland duct which penetrate the muscle and so stops the sweating activity.

The great effect of direct solar radiation on the sebum secretion in buffaloes followed by Friesians and then the other cattle breeds could be attributed to the black skin in the former two breeds. However the buffaloes showed a negative reaction to solar radiation by decreasing the sabum secretion while cattle breads showed positive reaction. As Emannuel (1938) stated that hee pressure and viscosity of the secreted sebum offers an increasing resistance to further output, it could be inferred that the melting of the high amount of sebum (92 mg./m.^{2}) in buffaloes by sun rays put more resistance on the glands activity to bring the secretion to a stop than the small amount of sebum in cattle breeds.

Buffaloes only showed a trend of age difference similar to humans most likely due to their great amount of secretion so any difference will prodnce significant variation than with the small amount of secretion in cattle.

In conclusion, sebaceous glands in buffaloes and cattle breeds showed adaptational activity with the variation in seasonal temperature. This sebaceous glands activity coinsides well with the other activities related to heat regulation, such as pili muscle centraction, sweating activity and vasomotor reaction in skin.

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نشاط الغدد الدهنية فى الماشية والجاموس تحت ظروف المناخ الحار

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الملخص

شملت هذه الدراسة التى تهدف الى معرفة اثر كل من الجنس والنوع الحيوانى والنوع الزراعى والعمر وفصول السنة والاثر المباشر للتعرض لأشعة الشمس على افراز الدهن لجلدى ٢٣ جاموس ، ٢٠ بقرة مصرية ، ٢٤ بقرة شورتهورن ، ٢١ بقرة فريزيان وقد انتهى البحث الى هذه النتيجة :

١ ــ كان الجاموس أكثر أنواع الحيوانات افرازا للدهن (١١١ مج/م٢) مقابل ٤٠ ، ٢٩ ، ٢٥ مج/م٢ فى كل من الفريزيان والشورتهورن والماشية المصرية على التوالى . كما كانت الفروق بين هذه الأنواع فى هذا الاعتبار معنوية جدا .

٢ ــ تأثر افراز الدهن باختلاف فصول السنة فى كل من الماشية والجاموس . فقد كان افراز الدهن شتاء اكثر منه صيفا كما كان معدل الزيادة فى الافراز أعلى فى الشورتهورن والفريزيان منه فى الماشية المصرية .

٣ ــ كان الافراز فى العجول الصغيرة اعلا منه فى الحيوانات الأكبر شتاء وان كانت الفروق بين المجموعات المصرية ليست معنوية .

٤ ــ سبب التعرض لأشعة الشمس المباشرة زيادة طفيفة فى افراز الدهن فى الماشية . وقد كان الافراز فى الفريزيان أكثرها وان كان الجاموس قد قل افرازه تحت هذا الظرف .

٥ ــ وصل معدل زيادة الدهن الى مستو ثابت بعد ازالة الدهن من جلد الحيوانات بساعتين فى الماشية بينما أخذ ذلك حوالى يوم فى الجاموس .

٦ ــ ولو أن مسطح الماشية الجلدى يحتوى على عدد أكبر من الجاموس فى النسيج الغددى الا أن الدهن المفرز فى الجاموس كان أكثر نظرا للنشاط الكبير لهذه الغدد فى هذا الحيوان ولأن الغدد الدهنية فى الجاموس ذات موارد دموية وشعرية غزيرة .