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Study on the Thermal Conductivity of Rabbit Pelts.

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Abstract

The thermal conductivity of different parts of twenty-one local meat-rabbit pelts were measured. The results show that there are extremely significant correlations between the pelt thickness and the cooling time (T) cool coeficient (h) and cooling value (H). Their correlation coefficients (r) are 0.94, -0.99 and -0.99, respectively. The differences among different pelt parts are extremely significant ($p < 0.01$), too.

Introduction

As other mammals, the thermal exchange of rabbits with the environment is mainly through the naked body surface when the environmental temperature is higher than that of their body surface, animals will get heat from the outside through the conduction of their skin and wool. Othewise, if the invironmental temperature is lower than their body surface, animals will lose heat by the same way. In order to measure the thermal conductivity of animal pelts, the katathermometer (i. e. cooling thermometer) is often used in China and abroad to determine the heat trasfering coefficients of pelts. So the heat gain or heat lost of animals would be calculated.

Measuring the thermal conductivity of rabbit pelts is of significance in the revealing of the ecological properties of rabbits, formulating of physiological parameters, and improving the feeding and management of rabbits. Furthermore, the measuring of thermal conductivity of pelts may estimate the heat preservation and insulation performances of the naked eye and hand appraisal.

Materials and methods

1. Materials

Twenty-one indigenous adult meat-rabbits were slaughtered and skinned after they were fed in laboratory (room temperature: 14-22° C) for three days. Apparatus such as normal temperature katathermometer (35-38° C) (figure 1) vacum drier, stopwatch, vernier caliper, normal thermometer, and et. al. were used.

2. Methods

2.1 Preparation of pelt samples: Three samples from the neck, back and belly parts of each pelt were preparated. Their thickness were measured by a vernier caliper. Then the samples were dried in a thermostated (40° C) container and sewed up as a small bay, the size of which is just right to cover the storing bulb of the katathermometer.

2.2 The calibrated katathermometer was heated in hot water (70-80° C), till the alcohol inside went up into the safety leulb and let il 1/2 - 2/3 filled. The storing bulb of the katathermometer was dried with a clean lowed, and the pelt bag prepared was slipped on it. Then the katathermometer was hanged in a vacuum drier together with a normal thermometer. The time for the alcohol inside the katathermometer decreasing from 38° C to 35° C was measured by a stopwatch. The environmental temperature was also recorded by the normal thermometer at the same time. The cooling values (H) and cooling coefficients (h) of the pelts were calculated by the following formulae. In order to get the reliable results, every sample must be measured for three times, and the average cooling time (T) of each sample was used.

$$H = \frac{F}{T} \qquad h = \frac{F}{(36.5 - t)\,T}$$

where: H .... cooling value T .... cooling time

h .... cooling coefficient F .... kata coefficient

t .... environmental temperature

Results and Analyses

The thickness and heat transfering properties of different pelt samples from twenty-one healthy adult rabbits have been measured. The results are listed in table 1.

Table 1. Thermal Conductivity of Rabbit Pelts

Measuring part	Number	Environmental temperature (℃)	Cooling time (T)(sec)	Cooling value(H) (milli-K/cm²/sec)	Cooling coefficient (h) (milli-k/cm²/℃/sec)	Skin thickness (mm)
Back	21	16.8±2.1	160.0±30.9	2.45±0.8	0.127±0.04	1.34±0.25
Neck	21	16.6±2.1	156.07±22.6	2.64±0.61	0.134±0.03	0.95±0.26
Belly	21	16.6±2.1	150.7±16.4	2.73±0.66	0.138±0.03	0.81±0.19
Average	21	16.7±2.1	155.59±23.3	2.61±0.69	0.133±0.03	1.03±0.27

From table 1, it can be found out that when the environmental temperature is 16.7° C, the time for katathermometer to decrease from 38° C to 35° C is 155.59 seconds, the cooling value and cooling coefficient of the pelts are 2.61 milli-caloie /cm/second and 0.133 milli-calorie/cm/° C/second.

Since the thickness of pelts is different, the cooling time, cooling coefficient and cooling value of different samples change regularly. The thicker the pelt is , the longer the cooling time will be, and the smaller the cooling coefficient and the cooling value. The correlation coefficient (r), regression coefficient (b) and intercept (a) between pelt thickness and the cooling time, cooling coefficient and cooling value have been got through the correlation and regression analyses among them (table 2).

Table 2. Relationship Between Pelt Thickness and T. h. H.

Correlation	correlation coefficient (r)	Intercept (a)	Regression coefficient (b)	t test of r (p)	Regression equation
Pelt thickness and T	0.94	139.12	15.93	<0.01	y=139.12+15.93x
Pelt thickness and h	-0.99	0.153	-0.02	<0.01	y=0.153 − 0.02x
Pelt thickness and H	-0.99	3.14	-0. 52	<0.01	y=3.140 − 0.52x

From table 2. it can be found out that there are extremely significant positive correlation (r=0.94) between pelt thickness and the cooling time. The thicker the pelt is, the longer the cooling time would be. There are extremely significant negative correlation between pelt thickness and the cooling coefficient and cooling value (r=-0.99). The thicker the pelt is, the smaller the cooling coefficient and cooling value would be, and the heat energy lost from a given area in a given time will be small, too, which is helpful for heat keeping and insulation. The t-test of correlation coefficients shows that all the p-value is smaller than 0.01, which indicates that the correlations between pelt thickness and T,h,H are extremely significant. Their realtionships can be expressed by the following linear regression figures (Figure 2,3,4).

Discussion

1. The pelt of animals is the medium for them to exchange heat energy with the environment. This exchange is affected by many factors, such as skin thickness and structure, wool density, surface area of wool and skin, and environmental temperature, humidity and airflow. This paper has studied only the relationship between pelt thickness and heat transfering properties. The conclussion that heat diffusion decreases as the pelt thickness increases has been reached. Other factors, which affect heat exchange, such as surface area of pelt, the quantity and function of sweat glands, subcutaneous blood vessel net, and et. al., need further studies in the future.

2. Rabbits have many ecological properties, such as high heat yield per kilogram of body weight, no sweat glands in their skin (except in the nose area), and dense wool on skin surface, so it is difficult for rabbits to diffuse body heat.
They cannot bear the hot climate. It has a profound significance to measure the heat conductivity of rabbit pelts in finding out the ecological characters and improving the feeding and management of rabbits.

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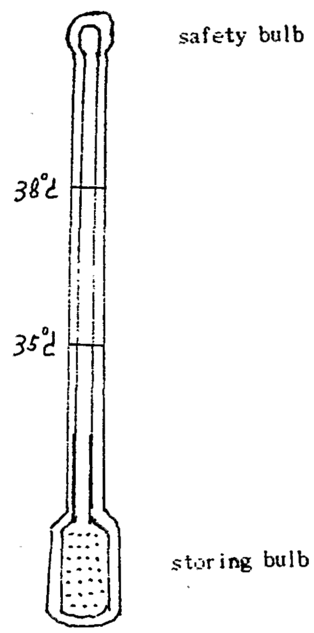

Figure 1 Katathermometer

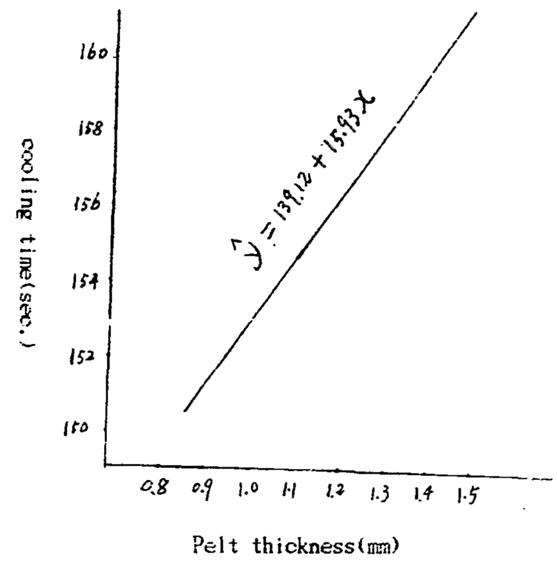

Figure 2 Regression graph between pelt thickness and cooling time

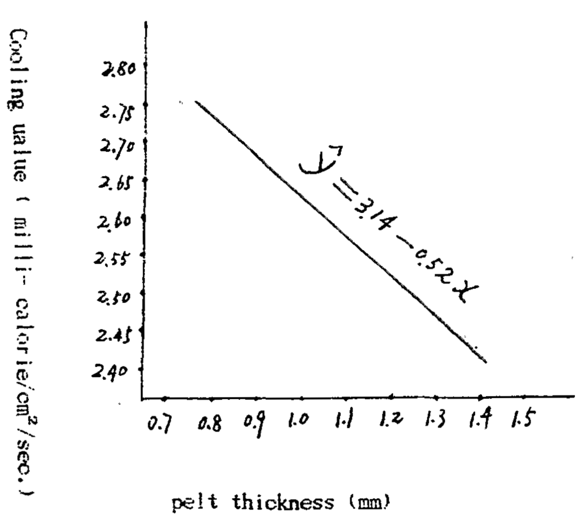

Figure 3 Regression graph between pelt thickness and cooling value

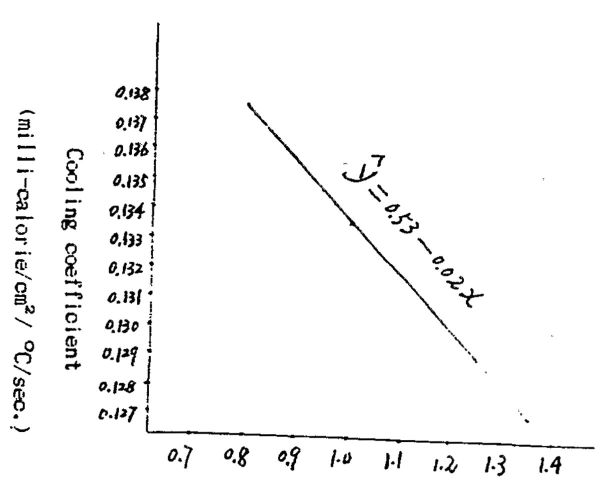

Figure 4 Regression gyaph between pelt thickness and cooling coefficient