THE EFFECT OF ENVIRONMENTAL FACTORS ON WEIGHT LOSS OF BROILERS

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This Thesis has now been updated with new research but the validity and the conclusions are still valid and submitted to:

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TABLE OF CONTENTS

ABSTRACT

Evaporative weight (W.L.) losses of eight week old broilers were measured under different environmental conditions namely, dry-bulb temperature, relative humidity, ventilation rate and time in confinement. Of the four factors considered, dry-bulb temperature, ventilation rate and time in confinement were significant at 99.5% confidence level in the analysis of variance. Relative humidity was significant only at the 90% confidence level: this was substantiated when the relative humidity term was eliminated from the multiple linear regression model (MLR) at 95% confidence level. The MLR Model is:

$$\% \text{ W.L.} = (-5.0918+0.0664T+0.2733H-0.1938V)$$

Where T= DB temperature, H=Hours in confinement and V=Airflow in cfm.

The above MLR has a correlation of 0.8550.

Body temperature and respiration rates were also measured under the above mentioned conditions. The broilers were able to maintain constant body temperatures by increasing their evaporative weight loss as environmental conditions became severe.

1.0 INTRODUCTION

A recent report, "An evaluation of Poultry Processing", prepared by the University of Georgia Experiment Station Committee on Automation in the Poultry Processing Industry (White, H.D et al) suggests that data should be collected on weight losses, mortality and carcass contamination now experienced by processors. The Committee also suggest that studies should be conducted on different environmental factors affecting these economic losses during holding, and on the feasibility and economics and environmentally controlled holding system.

Henry, W.R. and R.Raunikar showed that the weight losses of broilers during the live-haul were a substantial part of total marketing costs.

In North Carolina alone, the annual value of marketable weight lost between farms and plants was more than $500,000.

There were approximately 450 million broilers grown in Georgia in 1972. This amounts to approximately one and one half billion pounds of broilers. If the average shrinkage was only 1%, which is a conservative estimate, approximately 15 million pounds would be lost. This represents a sizable economic loss.

Nationwide the broiler consumption is 120 lb. /capita per annum. With a population of over 300 million, this equates to 36 billion pounds. 1% weight loss would equate to 360 million pounds loss. At $2.00/lb., the loss would be $ 720 million. Very substantial.

2.0 OBJECTIVES

1. **To investigate the effect of the following environmental factors on the evaporative weight loss of eight week old broilers during confinement conditions designed to simulate the live-haul situation:**
    - **I) dry bulb temperature, T**
    - **II) Relative humidity, R**
    - **III) Time in confinement, H**
    - **IV) Ventilation rate, V**
2. **To develop a multiple linear regression (MLR) model by which the percentage of weight loss of eight week old broilers during the live-haul as affected by the above mentioned environmental factors, could be predicted.**

3.0 LITERATURE REVIEW

An intensive literature review was conducted on this research. This was done manually using 3 x 5 index cards at the University of Georgia. Twenty-six (26) articles, papers were reviewed and the most relevant were by W. R Henry and R. Raunikar and H. D White et al. All were at the College Experiment Station at the University of Georgia. N. Kant in his MS thesis at UGA simulated the body temperature response of mature broilers during live haul.

Poultry, like mammals are homeothermic. The maintenance of a constant body temperature within a nature range requires a precise control system. Heat production (thermogenesis) and heat loss (thermolysis) must be kept within physiological range.

When the environmental temperature equals or surpasses body temperature, the bird depends solely on evaporative heat loss from the respiratory system. By evaporating water from the lungs, the homeotherm is able to survive lethal environmental temperatures.

Of the four environmental factors (dry-bulb temperature, relative humidity, ventilation rates and time in confinement) considered in this research, the significance of the first two factors on the evaporative heat loss has been depicted in the literature.

N. Kant had shown that the total weight losses (evaporative and fecal) of eight (8) week old broilers are 4 to 5% of body weight depending on the ventilation rates.

The entire literature review and bibliography are available on request.

4. 0 EXPERIMENTAL DESIGN AND PROCEDURE

4. 1 Design

To investigate the evaporative weight loss of broilers under different environmental conditions, a factorial design of the following factors was used

1. Dry -bulb temperature, 3 levels (75 deg., 85 deg., 95 deg. F)
2. Relative humidity, 3 levels (40%, 60%, and 80%)
3. Ventilation rates/bird, 2 levels (1 cfm, 2 cfm)
4. Time in confinement, 3 levels (2 hrs. 4 hrs. 6 hrs.)

The reasons for selecting the three dry-bulb temperatures are as follows:

1. 75 deg. F dry- bulb is within the thermoneutral range.
2. 85 deg. F dry-bulb is very close to the upper critical temperature of the thermoneutral range where sensible heat production is a significant part of total heat production.
3. 95 deg. F dry-bulb is above the upper critical temperature of the thermoneutral range. In order to maintain a constant body temperature, the bird maximizes heat loss by evaporative means

The three relative humidity's chosen represent typical humidity's encountered during the live-haul.

Ventilation rates of 1 cfm and 2 cfm per bird were chosen because six thousand birds are to be contained in the transport system designed by the Ag. Engineering Department; a ventilation rate in excess of 12,000 cfm (2 cfm/bird) would necessitate high HP fans. Kant's (10) work showed that 2 cfm/bird is adequate in preventing excessive physiological stress.

A time limit of six hours in confinement for each test was set because that is the maximum number of hours a truck-load of broilers is expected to be exposed to a constant dry-bulb temperature, relative humidity and ventilation rate.

Hence this constituted a 3x3x2x3 factorial experiment with 54 observations of weight losses needed to satisfy all treatments for one replication of the experiment. The experiment was replicated three times, therefore a total of 162 observations were recorded.

To obtain 54 observations for one replication, 36 broilers were required because 3 observations per two broilers were made in a single test, i.e. when time in confinement was 2, 4 and 6 hours. Therefore, 36 x 3 =108 broilers were used for the experiment.

4.2 Acclimatization of Test Birds

The broilers used in the experiment were raised in the environmental rooms in the Ag. Engineering Department. The chicks were obtained from the Central Soya processing plant in Athens. They were of a Vantress Arbor Acres cross.

The temperature in the rooms was kept between 80 deg. F – 85 deg. F, hence all birds were acclimatized to moderately high temperatures when they were placed in the test chamber.

4.3 Procedure

The broilers, eight weeks old, randomly selected, were taken off feed ten hours prior to the test. This stimulates a standard practice of commercial broiler growers. However, water was available to them until the test began. The mean weight of the two broilers was 3729 gm. (8.21 lb.) With a standard deviation of 250 gm. (0.55 lb.). Ninety-six percent of the broilers used weighed within two standard deviations of the mean weight, i.e. 52 out of 54 sets of 2 broilers.

For monitoring body temperature and respirations rates, coated thermocouples implanted in the pectoral muscle, and nickel coasted safety pins implanted above the pectoral muscle, were used respectively. The two broilers were then placed in a compartment wire cage (12in. x 10in. x 10in.). It was placed in the chamber and suspended from a lever balance. The environmental conditions (dry-bulb temperature, relative humidity and air flow) were at the specified test levels. The broilers faced the direction of air flow throughout the test as the cage was not big enough for them to turn around. They could however, stand or sit as they pleased.

Body weight, respiration rate and body temperature were recorded at the beginning of the test and every half hour thereafter for six hours.

Different broilers were used for every test. The temperature of the room in which the experiments were performed was kept within 5 ^{0} F the test air temperature to prevent condensation on the inside of the test chamber.

A pan containing mineral oil was placed beneath the wire cage so that feces and urine could be collected. The mineral oil prevented the moisture in the feces from evaporating, thus enabling the fecal and urinary weight loss to be determined for each test.

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5.0 EXPERIMENTAL EQUIPEMENT

The experimental equipment required for the research consisted of equipment that controlled and/or measured and recorded the four independent factors (dry-bulb temperature, relative humidity, ventilation rates and time) and the dependent variables (bird's weight loss, respiration rates and body temperature of the broilers)

Table 5. 1 shows the equipment and instruments and their accuracies. Other equipment not mentioned in Table 5.1 are:

1. The duct systems made of plywood, 1ft. square (inside dimensions) and 14ft. long, with the flow nozzle placed 6ft. from the fan end of the duct.
2. The test chamber: made of 3/8 in. Plexiglas with dimensions of 17in. x 25in. x32in. With a door on one side, large enough for the wire cage (in which the two broilers were placed) to be moved into and out of the chamber.

Pegboard (figure 5.1) was used in the test chamber to provide for uniform distribution of the air across the chamber cross-section. To check the uniformity of air flow, air velocities were measured at various points along the pegboard, and no appreciable variation was found.

An attempt to simulate live-haul conditions in the test chamber was made by using equivalent flow rates. This was done by having air velocities over the birds in the chamber equal to those in the coop less mechanized transport system being designed by the A. Engineering Department at the University of Georgia.

Ventilation rates of 1 cfm and 2 cfm per bird in the actual transport system represent air velocities of 21 ft. /min. and 42 ft. /min. respectively. To obtain these air velocities in the test chamber, air flow rates of 45 cfm and 90 cfm, respectively, were required.

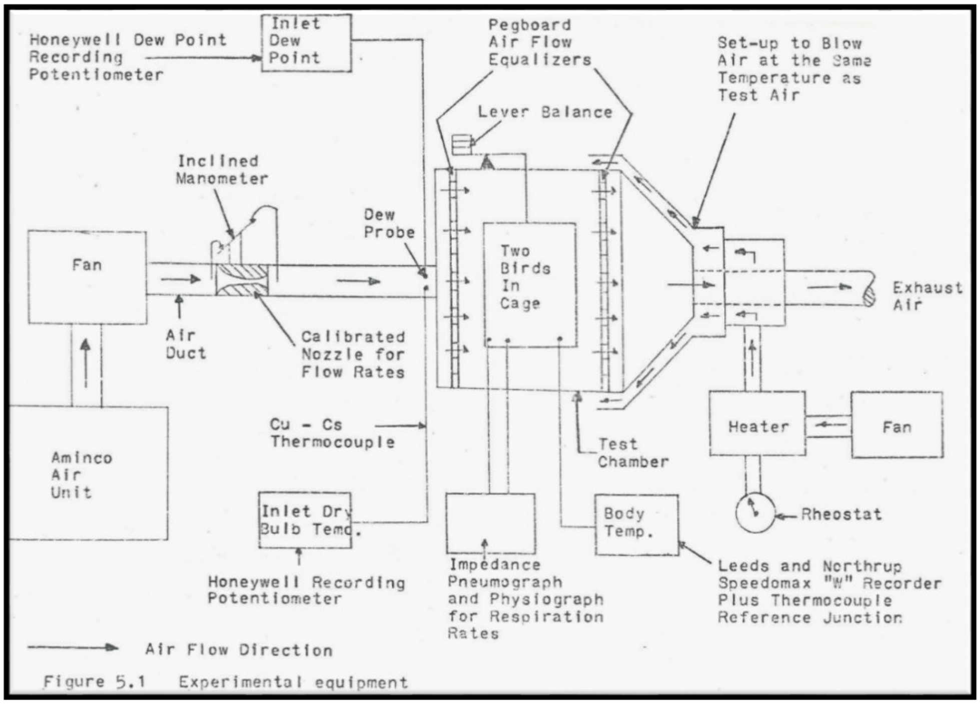


Figure 5.1 Experimental Equipment

Physical Quanity Controlled and/or Measured	Equipment or Instrumentation Used	Accuracy
Air Supply	a. Aminco-Aire Unit. Cat Nos. 4-5475 to 4-5478, American Instrument Co. Supplies air at constant dry-bulb temperature and relative humidity	+/- 0.75°F db +/- 0.5 RH
	b. Fan: responsible for the flow rates at the high pressures needed for the experiment	
Dry-Bulb Temperature	a. Cu - Cs thermocouple placed 6 in. from the entrance of the test chamber	+/- 0.5°F +/- 0.44°F
	b. Honeywell Electronic 16 recorder	
Relative Humidity	a. Honeywell dew-probes S5P129B 021. Dew point temperature 10° to 90°F. Maximum ambient air temperature 180°F, placed 6 in. from the entrance of the test chamber	+/- 0.44°F
	b. Honeywell dew point recorder Electronic 16.	
Ventilation Rates	a. Calibrated flow nozzle. Cox Instrument Division Models.	+/- 1% or
	b. Conventional inclined manometer	
	c. Calibration curve of Delta P verses flow rate	
Time in Confinement	Clock	+/- 30 sec
Weight Loss	Ohaus - Lever Balance. Union Co. Model No. 1119.	+/- 2 gms
	Capacity 20 Kg	
Body Temperature	a. Cu - Cs thermocouple coated with INSL-X E 33N, an insulating tool dip with high dielectric strength. The thermocouple was implanted in the area of the pectoral muscle, and sutured to hold it in place	+/- 0.5°F +/- 0.2°F 0.2°F per Division
	b. Reference Junction box. Pace Engineering Co. Model LR JA3-8TT	
	c. Leeds and Norhrup Speedomax w/ Compact Azar Recorder - calibrated for temperature range of 100°F - 120°F, i.e. 20°F span for 100 divisions of the recorder	
Respiration Rates	a. Nickel coated safety pins implanted above the pectoral muscle.	Response time = 50ms
	b. Impedance Pneumograph. Narco Bio-Systems Inc. Part No. 93-800-70	Sensitivity =50mV/cm
	c. Phsiograph. Narco Bio-Systems Inc. DMP - 4A	

Table 5.1 Experimental Equipment and Accuracy.

Figures 5.2: Physiography for monitoring respiration rates. 5.3: Set-up showing cage suspended from lever balance. 5.4: General set-up showing physiography, impedance pneumograph and potentiometer. 5.5: physio graph and impedance pneumpgraph for measuring respiration rates; 5.6: Broilers in cage facing direction of air flow. 5.7 Two broilers in the cage in the test chamber

11

Figures 5.2

Figure 5.3

Figure 5.4

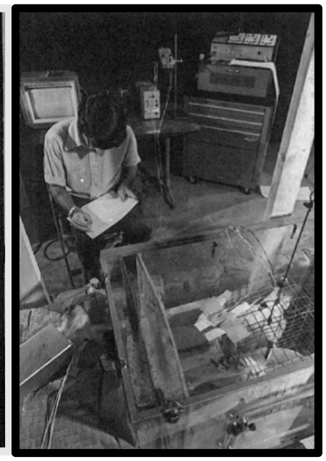


Figure 5.5

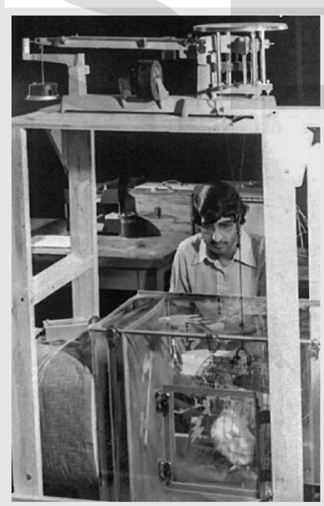


Figure 5.6

Figure 5.7

6.0 RESULTS AND DISCUSSION

6.1 Percentage Evaporative Weight Loss

The percentage evaporative weight losses calculated at 2, 4 and 6 hours were based on the original weight. The results for replication one with T = 75^{0}F, RH = 75% and V= 1 cfm are given below.

Time, hours	0	2	4	6
Weight, gms.	4119	4101	4089	4084
Weight loss, gms.		18	30	35
Weight loss, %		0.44	0.73	0.85

Table 6.1 represents the summary of results for all tests of % evaporative weight loss as effected by environmental conditions.

				Dry Bulb Temperature, °F								
				75			85			95		
				Relative Humidity %			Relative Humidity %			Relative Humidity %		
				40	60	80	40	60	80	40	60	80
Time, Hours	2	V. Rates, cfm	1	0.44	1.08	0.53	0.47	1.41	1.32	1.08	0.94	1.62
				0.32	0.61	0.22	0.50	1.44	0.86	1.14	1.67	1.42
				0.54	0.69	0.24	0.89	0.54	0.46	0.79	0.99	1.46
			2	0.33	0.43	0.27	1.09	0.59	0.59	1.00	1.19	1.10
				0.65	0.20	0.17	0.94	1.11	0.44	1.71	1.27	1.53
				0.46	0.33	0.25	0.39	0.47	0.19	0.62	1.03	1.06
	4	V. Rates, cfm	1	0.73	1.38	0.67	1.01	1.83	1.75	2.11	2.60	2.89
				0.74	0.66	0.41	0.80	1.93	1.21	2.28	2.38	2.17
				1.27	1.25	0.57	1.20	1.19	1.40	1.29	2.00	2.49
			2	0.50	0.54	0.36	1.59	1.30	1.08	2.22	2.04	2.06
				1.58	0.62	0.25	1.53	1.53	0.87	2.57	1.90	2.59
				0.71	0.50	0.56	1.08	0.75	0.45	1.34	1.87	1.72
	6	V. Rates, cfm	1	0.85	1.79	1.02	1.70	2.47	2.27	3.08	3.45	3.49
				1.46	1.08	0.65	1.00	2.42	1.74	2.73	3.06	2.84
				1.62	1.69	0.70	1.59	1.67	1.91	1.67	2.46	3.32
			2	0.80	0.89	1.04	2.13	1.92	1.55	3.11	3.02	3.31
				1.92	1.10	0.45	1.88	1.81	1.31	3.17	2.73	3.64
				0.84	0.64	0.73	1.53	1.14	0.72	2.09	2.41	2.41

Percentage evaporative weight loss as effected by environmental conditions for replications 1, 2 and 3.

6.2 Analysis of Results of Percentage Evaporative Weight loss.

The two methods employed in analyzing the weight loss data are the analysis of variance for the factorial experiment and the development of multiple linear regression (MLR) models for the dependent and independent variables

6.2.1 Analysis of Variance for the 3 x 3 x 2 x 3 Factorial Experiment with 3 Replications

The analysis was carried out with the aid of desk calculator and the results are summarized in the ANOVA Table 6.2.1.

ANOVA for the 3x3x2x3 factorial experiment with 3 replications

Source	d.f.	Sum of Squares	Mean Squares	F-Value	
Temp., T	2	48.65032	24.32516	225.10790	****
Rel. Humidity, R	2	0.67454	0.33727	3.12113	*
V. Rates, V	1	1.52154	1.52154	14.07790	****
Time, H	2	32.31609	16.15804	149.5284	****
TxR	4	3.17842	0.79460	7.35352	****
TxV	2	0.19883	0.08841	0.81815	N.S.
TxH	4	5.35772	1.33943	12.39524	****
RxV	2	2.67960	1.33980	12.39866	****
RxH	4	0.02874	0.00718	0.06644	N.S.
VxH	2	0.03604	0.01802	0.16675	N.S.
TxRxV	4	1.02284	0.25571	2.36637	*
TxRxH	8	0.24973	0.03121	0.28882	N.S.
TxVxH	4	0.09253	0.02313	0.21404	N.S.
RxVxH	4	0.11523	0.02880	0.26651	N.S.
TxRxV;;H	8	0.14372	0.01796	0.16620	N.S.
Between Reps.	2	3.39539	1.69769	15.71062	
Within Cells	106	11.45515	0.10806	N.S. -Not Significant	
Total	161	111.11543		* -90% Confidence Level	
				**** -99.5% Confidence Level	

6.2.2 Multiple Linear Regression (MLR) Model

The computer program used was Multiple Regression Program (MULREG) Public (for use on IBM 360, written in PL-I Language). The partial ts are tested for significance. Then if the minimum t is non-significant at the 5% level, the variable which that partial t is testing is eliminated from a similar cycle. When all ts are significant, the equation is accepted as being the best of the equations that could be obtained from the initial equation.

The analysis of variance showed that three of the interaction terms are significant at the 99.5% confidence level. They were not included in the regression models since it was believed that the multiple linear regression models used would explain the weight losses adequately. This was substantiated with the high correlation coefficients obtained.

The model fitted was of the forms:

% Weight loss, W.L = $\beta_0 + \beta_1 T + \beta_2 R + \beta_3 H + \beta_4 V$

Where β0, β_1, β_2, β_3 and β_4 are coefficients to be determined.

T = dry-bulb temperature in deg. F

R = relative humidity in percent

H = time in hours

V = ventilation rates cfm/bird.

Using the program, the following initial model was obtained:

% W.L. = - 5.0682 + 0.0664T – 0.0004R + 0.2733H – 0.1938V with correlation coefficient of 0.8559.

The regression analysis of variance for model (6.2.2) is:

Source	d.f	sum of sq.	Mean sq.	F Value
Regression	4	81.4042	20.3511	107.54 **
Residual	157	29.7112	0.18924	
Total	161	111.115		

When the t-value for 157 d.f and alpha = 0.05 (1.96) was supplied, the relative humidity term was eliminated from the regression.

A new model was then fitted % W.L. = $\beta_0 + \beta_1 T + \beta_2 H + \beta_3 V$

Where β_0, β_1, β_2, β_3 were re-determined.

The new model was:

% W.L. = - 5.0918 + 0.0664T +0.2733H -0.1938V with a correlation coefficient of 0.8550.

The regression analysis of variance for model, 6.2.2a, is:

Source	d.f	sum of sq.	Mean sq.	F Value
Regression	3	81.397511	27.1325	144.25 **
Residual	158	29.717861	0.188088	
Total	161	111.115372		

When the t-value for 158 d.f and alpha = 0.05 (1.96) was supplied, all remaining variables were found to be significant.

In MLR model the ventilation rate term has a negative coefficient. In order words, as the ventilation increases, percentage evaporative loss hence q (evaporation) decreases. The increased air velocity of the higher ventilation rate probably increases the convective heat loss from the bird enabling the reduction in the insensible heat loss and still have a balance between thermogenesis and thermolysis.

For any given combination of time in confinement and dry-bulb temperature, increasing the ventilation rate from 1 cfm/bird to 2 cfm/bird produced a percentage weight loss decrease of 0.194%.

Increasing temperature produces increased evaporative weight loss. This is to be expected with the three temperatures used.

The number of hours a broiler is confined under any given combination of environmental conditions has a significant result on the percentage evaporative weight loss as indicated in model. This is for the live haul.

Using equation 6.2.2a, the predicted % weight loss for the 3 temperatures at the end of 6 hours in time in confined for the 2 ventilation rates is in Table 6.2.2 below:

	Dry Bulb Temperatures. °F		
Ventilation Rates	75°F	85°F	95°F
1 cfm	1.33	2.00	2.66
2 cfm	1.14	2.58	2.47

Chart 6.2.1 Percent Evaporative Weight Loss by Time in Confinement and Dry Bulb Temperature

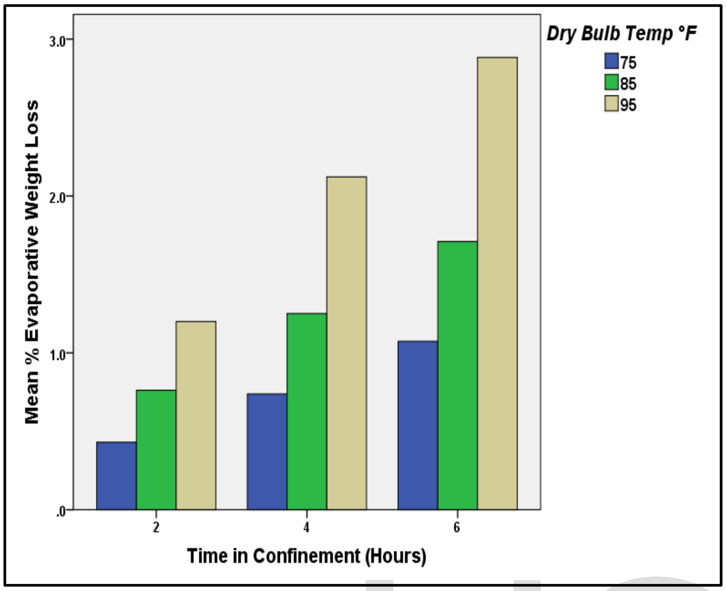


Chart 6.2.2 Percent Evaporative Weight Loss by Time in Confinement and Relative Humidity

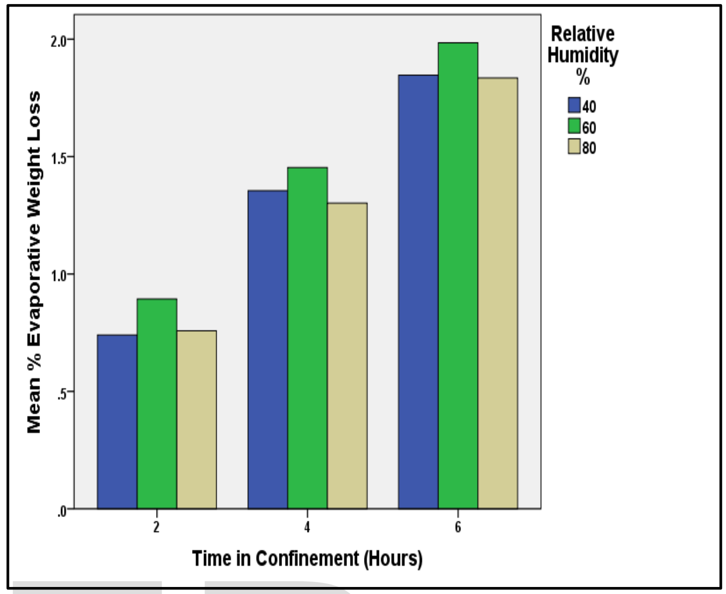


Chart 6.2.3 Percent Evaporative Weight Loss by Time in Confinement and Ventilation Rate

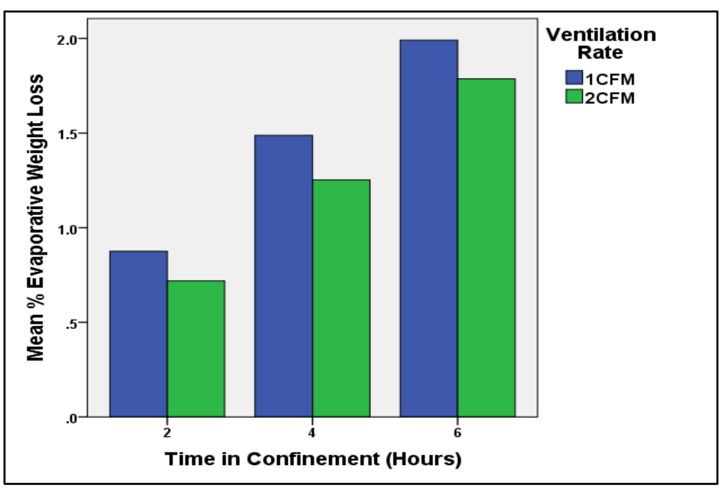
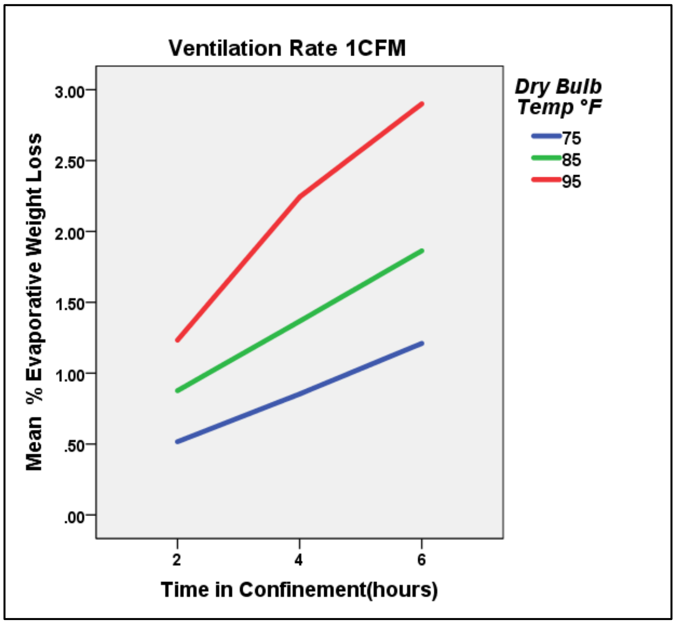


Chart 6.2.4. Percent Evaporative Weight Loss by Dry Bulb Temperature and Time in Confinement



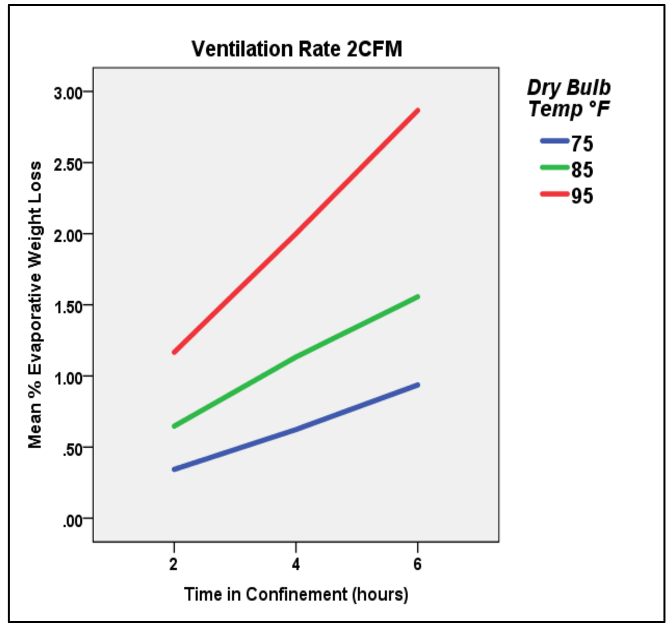
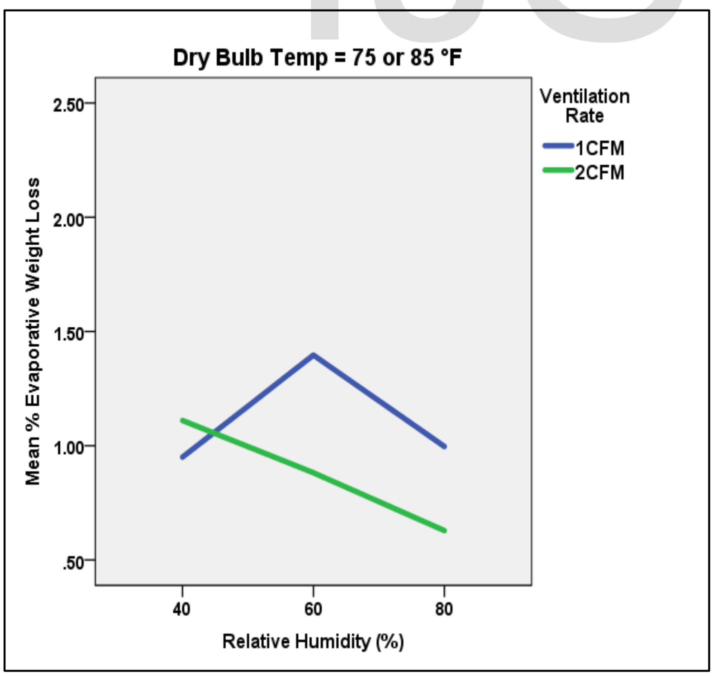
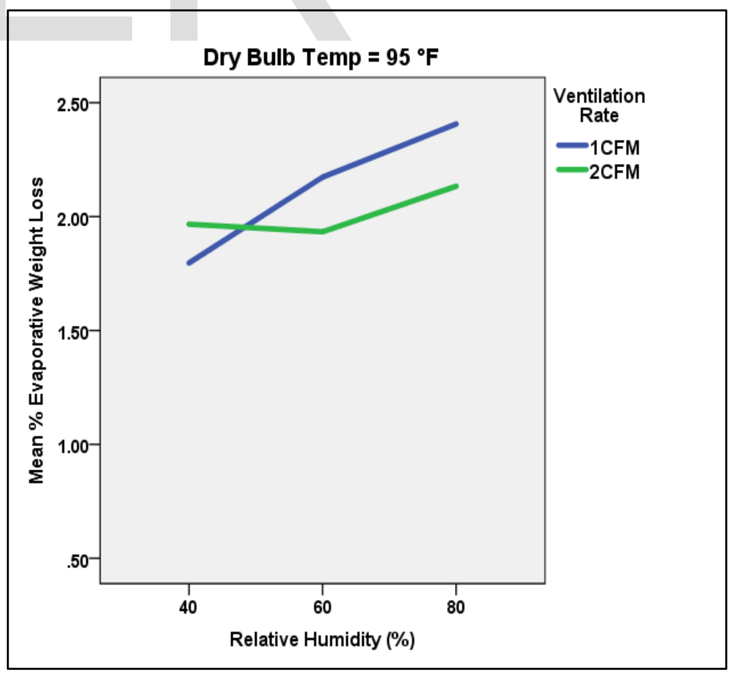


Chart 6.2.5. Percent Evaporative Weight Loss Relative Humidity and Ventilation Rate





6.3 Total Weight Loss (Evaporative and Fecal)

Detailed results of total weight loss are given in Table 6.3 below.

		Dry Bulb Temperature, °F								
		75			85			95		
		Relative Humidity %			Relative Humidity %			Relative Humidity %		
		40	60	80	40	60	80	40	60	80
V. Rates, cfm	1	0.85	1.79	1.72	1.70	3.77	3.52	4.8	5.89	6.03
		2.67	1.62	1.03	2.24	3.55	2.74	3.79	4.55	4.86
		4.12	3.52	0.70	3.29	2.13	2.70	2.66	4.63	6.30
	2	0.80	0.89	2.50	2.16	2.32	2.53	4.11	4.08	4.53
		3.22	1.92	1.42	2.38	3.65	1.59	4.06	4.08	5.25
		1.90	1.02	0.98	2.14	1.82	0.72	2.49	3.02	3.80

Summary of results of percentage total weight loss (evaporative and fecal) at the end of six hours

Briefly it can be said that in many instances the total weight lost is twice the evaporative weight loss, the highest observed loss being 6.30% when T = 95 deg. F, RH = 80% and V = 1 cfm/bird.

A multiple linear regression model was set up for the total weight loss at the end of six hour. The final model, after the relative humidity terms was eliminated at 95% confidence level is:

% Total Weight Loss, W. L. = - 7.0351 + 0.1285T – 0.6589V ………………. (6.3a)

With a correlation coefficient of 0.7629.

When using (6.3.a), the predicted % weight losses at the end of 6 hours for the 3 temperatures and 2 ventilation rates are given in Table 6.3a below:

	Dry Bulb Temperatures. °F		
Ventilation Rates	75°F	85°F	95°F
1 cfm	1.95	3.24	4.53
2 cfm	1.29	2.58	3.87

6.4 Evaporative Weight Loss and Respiration Rates

The summary of results for respiration rates as effected by environmental conditions is given in Table 6.4 below.

Time, Hours		V. Rates, cfm		Dry Bulb Temperature, °F								
				75			85			95		
				Relative Humidity %			Relative Humidity %			Relative Humidity %		
				40	60	80	40	60	80	40	60	80
	2		1	24	38	44	77	184	122	230	262	275
				27	20	25	33	150	219	168	261	243
				38	57	33	60	155	231	136	255	330
			2	33	32	25	64	106	150	207	287	248.00
				27	21	27	42	108	159	270	231	315
				30	30	36	45	77	36	215	228	321
	4		1	21	31	33	89	115	139	210	244	300
				24	21	23	38	153	252	207	273	225
				32	44	38	60	167	240	186	267	258
			2	30	28	24	76	58	139	200	232	241
				28	35	24	81	117	150	252	246	312
				29	27	32	93	33	30	224	300	309
	6		1	28	30	22	71	164	128	244	275	274
				27	22	25	32	161	135	216	261	237
				30	27	38	105	102	249	279	257	255
			2	29	30	22	76	90	158	200	214	236
				24	24	22	48	38	95	234	258	243
				27	27	24	74	50	26	236	267	282

Respiration rates (breaths/min) as effected by environmental factors for replications 1, 2 and 3

Since birds do not have sweat glands, all the evaporative water loss is through the respiratory system, /at 75 deg. F, the respiration rates varied from 21 breaths/min. As the dry-bulb temperature was raised, the respiration rates increased sharply with the maximum of 330 breaths/min. when T = 95 deg. F, /rh = 80% and V = 1 cfm.

A simple linear regression was run for evaporative weight loss on respiration rates. The statistical model, using the (MULREG) Public computer program is:

% Weight Loss, W. L. = 0.662393 + 0.005371 RR …. (6.4)

Where RR = respiration rates in breaths/min.

The regression analysis of variance for model (6.4) is:

Source	d.f	sum of sq.	Mean sq.	F value
Regression	1	46.536657	46.53666	115.13 **
Residual	160	64.578715	0.403617	
Total	161	111.115372		

The correlation coefficient for model (6.4) is 0.6472. When the t-value was applied, the respiration was found to be significant.

6.5 Body Temperature

Body temperature of the broilers was monitored primarily to reduce the chance of the broilers dying while they were in the environmental chamber. If the body temperature reached 112 deg. F, the bird was removed from the chamber. Only one broiler had to be removed from the chamber out of the 108 used.

Table 6.5 gives the body temperature as effected by environmental factors.

				Dry Bulb Temperature, °F								
				75			85			95		
				Relative Humidity %			Relative Humidity %			Relative Humidity %		
				40	60	80	40	60	80	40	60	80
Time, Hours	2	V. Rates, cfm	1	106.2	106.5	106.8	106.5	107.6	107.2	108.2	108.0	108.6
				108.4	108.4	108.4	108.4	108.0	108.4	108.4	108.6	108.8
												108.6
			2	106.3	106.3	106.6	106.0	106.8	107.4	108.3	107.0	108.6
				108.3	106.3	108.3	108.4	108.5	108.4	108.6	108.5	108.6
												108.4
	4	V. Rates, cfm	1	16.2	106.5	106.8	106.6	107.5	107.0	108.1	109.7	108.4
				108.4	108.3	108.3	108.4	108.0	108.4	108.5	108.6	108.9
												108.8
			2	106.3	105.8	106.9	106.1	106.7	107.0	108.5	107.6	109.9
				108.4	108.4	108.3	108.50	108.5	108.4	108.5	108.5	108.6
												108.4
	6	V. Rates, cfm	1	106.1	106.9	106.8	106.7	107.4	107.1	108.7	111.0	109.2
				108.4	108.3	108.3	108.4	108.2	108.4	108.5	108.6	109.0
												109.0
			2	105.9	106.0	106.8	106.0	106.7	107.0	108.3	108.3	110.6
				108.4	108.4	108.4	108.5	108.4	108.5	108.5	108.5	108.9
												108.6

Average body temperature (°F) as effected by environmental factors.For replication 3, body temperature was only taken for 95°F and 80% RH

APPENDIX

Available upon Request.

7.0 CONCLUSIONS

1. The results show that the dry-bulb temperature, time in confinement and ventilation rate were highly significant factors influencing evaporative weight loss. Relative humidity was not.

2. Computed weight losses using the multiple linear regression equation (6.2.2a) compare closely with weight loss data from the field taken by other researchers (Henry, W.R and R.Raunikar, B.M.Freeman and C.Romijn and Lokhorst). Thus, equation can be used to predict weight loss as now measured by the processors for mature boilers. Predicted evaporative weight losses at the end of six hours using equation.
   Equation 6.2.2a is: % W.L. = (-5.0918+0.0664T+0.2733H-0.1938V), R=0.8550

3. In the multiple linear regression model for total weight loss at the end of six hours, equation (6.3a), dry-bulb temperature, time in confinement and ventilation rate were significant factors. Relative humidity was not. Total weight loss was approximately twice the evaporative weight loss in many instances. Predicted total weight losses using equation (6.3a) are given in Table 6.3.
   Equation 6.3a is % Total W.L. = (-7.0351+0.1285T-0.6589V), R=0.7629

4. Multiple linear regression models set up for each of the levels of dry-bulb temperature considered, I. e. 75ºF, 85ºF and 95ºF. For the statistical model at 75ºF, (6.2.3a), all terms in the model, including relative humidity, are significant at 95% confidence level. At 85ºF, all the factors studied were statistically significant except relative humidity (equation 6.2.3b). At 95ºF, ventilation rate was not significant at the 95% confidence level (equation 6.2.3c).
   Equation 6.2.3a for 75 deg. F is: %W.L. = (1.0016-0.0092R+0.1599H-0.2256V), R=0.7394
   Equation 6.2.3b for 85 deg. F is: %W.L. = (0.6811+0.2369H-0.2593V), R=0.7269.
   Equation 6.2.3c for 95 deg. F is: %W.L. = (-0.2031+0.0096R+0.4232H), R=0.8784

5. Since all evaporative heat loss in broilers is through the respiratory system, a simple linear regression model was set up between percentage evaporative loss and respiration rates. The regression was significant, with weight loss being directly dependent on respiration rate.

6. In conclusion, the models developed from these tests can be used to predict weight losses (evaporative and total) for eight week old broilers in confinement for 2, 4 and 6 hours for temperature range of 75ºF, to 95ºF and ventilation rates of 1 and 2 cfm/bird.

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