

Effect of environmental temperature on performance and on physiological and hormonal parameters of gilts fed at different levels of digestible energy

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Abstract

Forty crossbreed gilts were kept in an environment of thermal comfort ($22.7 \pm 1.56^{\circ}\text{C}$) and another 40 in a heat stress environment ($31.7 \pm 1.40^{\circ}\text{C}$), with average initial weights of 15.2 ± 0.87 and 15.3 ± 1.14 kg, respectively. The aim of the trial was to evaluate the influence of environmental temperature on performance, accretion rates of carcass protein and fat and physiological and hormonal parameters. Experimental diets containing five levels of digestible energy (13.40, 14.03, 14.65, 15.28 and $15.91 \text{ MJ DE feed kg}^{-1}$) were supplied ad libitum until the end of the experiment, when the animals reached the average weight of 30.0 ± 1.88 and 29.5 ± 1.72 kg in the thermal comfort and heat stress environments, respectively. The weight gain and the intake of the diet, protein and energy by the gilts kept in a 32°C environment were, respectively, 8.78, 8.22, 8.12, and 8.32% lower ($P < 0.01$) than those of gilts kept in a 22°C environment. The environmental temperature did not influence ($P > 0.05$) feed : gain ratio, conversion ratio and the efficiency of protein and energy utilization. The gilts kept under heat stress showed greater ($P < 0.01$) ratios of fasting weight/live weight and carcass weight/fasting weight. However, their fat deposition rate was 12.8% less ($P < 0.01$), while that of protein did not change ($P > 0.10$) in relation to those animals kept in thermal comfort. Environmental temperature influenced ($P < 0.01$) the absolute and relative weights of all organs evaluated, gilts kept thermal comfort having heavier organs. The serum blood concentrations of the thyroid hormones, tri-iodothyronine and thyroxine, were reduced ($P < 0.01$) at the high temperature. No difference was observed in the rectal temperature of gilts kept in the two environments. However, the respiratory rate of the animals under heat stress rose ($P < 0.01$) by 36.1%. Despite lesser weight gain as well as protein and energy intake, the physiological and hormonal adjustments of the animals kept at a high temperature allowed them to maintain their efficiency of protein and energy utilization, the protein deposition rate at values

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similar to those of the gilts kept in a thermal comfort environment. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

Swine react to extreme temperatures by adjusting their feed intake (FI) and/or changing the heat exchange with their environment (Fialho and Cline, 1991; Verstegen and De Greef, 1992), depending upon the feeding system and the handling conditions the animals are subjected to. Besides reducing FI, to reduce body heat production to maintain thermal balance, the animal changes its respiratory rate, and this helps the maintenance of the body temperature. According to Fialho (1994), evaporation is one of the major mechanisms for heat loss in swine, and it occurs mainly through the respiratory tract, brought about by the increase in the respiratory rate of those animals. According to National Research Council – NRC (1981), several authors found that a high-temperature environment reduces thyroid activity and this change may be as associated to changes in intestinal motility and feed passage rate. The change in the physiological and metabolic responses of swine kept at high temperatures will consequently result in change in their performance and carcass composition. Nevertheless, according to Verstegen and Close (1994), the environmental effects may be smoothed or reduced by providing feed that brings about reduced heat increment.

This study was carried out to evaluate the effects of constant thermal environments (22 and 32°C) on the performance and on physiological and hormonal parameters of gilts fed diets with different digestible energy (DEI) content.

2. Materials and methods

Data were used from 80 crossbreed gilts at their initial growth stage. Forty gilts were kept in thermal comfort and the other 40 gilts in heat stress. Their average initial weights were, respectively, 15.2 ± 0.87 and 15.3 ± 1.14 kg. A randomized blocks experimental design in a 2×5 factorial arrangement (environmental temperatures, 22 and 32°C, versus DEI levels) were used. In each environment the animals, in-groups of two, were fed the experimental diets with different levels of DEI (13.40, 14.03, 14.65, 15.28 and 15.91 MJ DE feed kg^{-1}). Experimental diets (Table 1) and water were supplied ad libitum to the gilts.

Internal room temperature was kept steady, through the use of six heaters in two parallel rows, about 40 cm above the floor. These heaters were coupled to a thermostat regulated to the desirable temperature and two air conditioners (18,000 BTU each) linked to a thermostat regulated to the desirable comfort temperature. The thermostat as well as other environment-measuring equipment (maximum and minimal temperature thermometers, dry and humid bulbous thermometers, black globe thermometer) were kept

Table 1
Percentage composition of the experimental diets

% Ingredient	Digestible energy level (MJ feed kg ⁻¹)				
	13.40	14.03	14.65	15.28	15.91
Maize	46.85	46.85	46.85	46.85	46.85
Soybean meal	32.83	32.83	32.83	32.83	32.83
Wheat meal	6.00	6.00	6.00	6.00	6.00
Dicalcium phosphate	1.14	1.14	1.14	1.14	1.14
Limestone	0.97	0.97	0.97	0.97	0.97
Mineral mix ^a	0.05	0.05	0.05	0.05	0.05
Vitamin mix ^b	0.15	0.15	0.15	0.15	0.15
Salt	0.35	0.35	0.35	0.35	0.35
BHT (beta-hydroxy-tolueno)	0.01	0.01	0.01	0.01	0.01
Soybean oil	0.50	3.27	5.57	7.87	11.10
Starch	6.94	5.04	4.15	3.26	0.37
Washed sand	4.21	3.34	1.93	0.52	0.18
Calculated composition ^c					
Digestible energy(MJ kg ⁻¹)	13.40	14.03	14.65	15.28	15.91
Crude protein (%)	19.50	19.50	19.50	19.50	19.50
Lysine (%)	1.08	1.08	1.08	1.08	1.08
Calcium (%)	0.75	0.75	0.75	0.75	0.75
Total phosphorus (%)	0.56	0.56	0.56	0.56	0.56

^a Mineral mix containing: iron, 90 g; copper, 10 g; cobalt, 2 g; manganese, 40 g; zinc, 70 g; iodine, 2 g; and excipient q.s.p., 500 g.

^b Vitamin mix containing: vitamin A, 10,000,000 IU; vitamin D3, 1,000,000 IU; vitamin E, 15,000,000 IU; vitamin B1, 3.0 g; vitamin B2, 3.0 g; vitamin B6, 1.5 g; panthotenic acid, 12.0 g; vitamin C, 30.0 g; vitamin K, 25 g; nicotinic acid, 22.0 g; vitamin B12, 22.0 mg; folic acid, 0.6 g; biotin, 0.1 g; antioxidant, 30.0 g; and inert material, 1000 g.

^c Composition calculation based on ingredient analysis at the Federal University of Viçosa Animal Science Laband according to Rostagno et al. (1992).

halfway up in a dry cage in the center of the room. Instrumental readings were taken daily, at 8:00, 12:00 and 16:30 hours.

Throughout the experiments, internal room conditions in the comfort and heat stress environments were respectively: temperature (22.7 ± 1.56 and $31.7 \pm 1.40^\circ\text{C}$), relative humidity (74.5 ± 4.48 and 64.7 ± 7.91), black globe and humidity index – BGHI (70.4 ± 0.59 and 81.1 ± 1.28) and black globe temperature (23.1 ± 0.42 and $31.5 \pm 0.48^\circ\text{C}$).

Once a week during the trial, rectal temperature and respiratory rate were recorded, always at 8:00 hours in each environment. Rectal temperature was taken by individual-reading clinical thermometer, introduced for 2 min into the rectum. Respiratory rate was measured by counting hip movements of the animal for 15 s and multiplying by 4, to obtain the data per minute.

At the end of the experiment, when the gilts reached the average weight of 30.0 ± 1.88 and 29.5 ± 1.72 kg, respectively, for thermal comfort and heat stress environment, blood samples were collected from all animals. This was done by orbital sinus puncture (Friend and Brown, 1971), to determine thyroid, tri-iodothyronine (T₃) and thyroxine (T₄) hormones in the blood serum, using BIOLAB immunoenzymatic determination kits and

the equipment known as Vitek Systems, AXIA 2 and bioMerieux. Prior to blood samples collection (between 11:00 and 11:30 hours), the gilts were fasted for 3 h.

The animals were slaughtered at the end of the experiment, after 24 h of fasting. Carcass data from additional group of four animals initially slaughtered at 15.3 ± 0.91 kg and from four animals of each experimental diet, totaling 20 carcass in each environment, were used. The protein and fat deposition rate in the carcass was determined. Slaughtering and carcass processing to obtain samples were carried out according to the methodology described by Donzele et al. (1992).

A pre-drying was carried out in the collected samples due to their high fat concentration in an oven with forced ventilation at 60°C for 72 h. After that, fat was then extracted by the Soxhlet method for 4 h and the residue was ground. Water and the fat removed from the samples were taken into account, to correct values in subsequent analyses.

The dried, unextracted and ground samples were packed for further analyses. Analyses of protein and fat in the samples were done by 'Kjeldahl' methods and by 'soxhlet' extraction according to Silva (1990), respectively.

Fat and protein deposition rates in the carcass were calculated by comparing carcass composition of the animals at the beginning (15.3 ± 0.91 kg) and at the end of the experiment, in the thermal comfort and heat stress environments.

Liver, kidneys, heart and lungs were removed from all slaughtered gilts (20 from thermal comfort and 20 from heat stress environments). After that they were hung in hooks to obtain a good blood drainage, and they were weighed.

The statistical analyses of the performance variables (weight gain, FI and feed : gain ratio (FC)), fat and protein deposition rates of in the carcass, thyroid hormone concentration and organ weights were realized using SAEG Computer Package (Systems for Statistical and Genetic Analyses), elaborated by Federal University of Vicosa – UFV (1983).

3. Results

In Table 2 are shown the results of performance and daily intake of protein (PI) and DEI of gilts from 15 to 30 kg, kept in environments of thermal comfort ($22.7 \pm 1.56^{\circ}\text{C}$) and heat stress ($31.7 \pm 1.40^{\circ}\text{C}$) fed with different energy levels. There was no interaction ($P > 0.10$) between dietary energy levels and environmental temperature for all evaluated parameters.

However, the energy intake linearly increased in the thermal comfort ($P < 0.02$) according to the regression $\hat{Y} = 1076.85 + 0.952X$ ($r^2 = 0.70$) and was not influenced in heat stress environment. The FC ratio linearly improved with the increase of the dietary energy levels in comfort ($P < 0.05$) and heat stress ($P < 0.09$) environments according to the regressions $\hat{Y} = 2.9756 - 0.000297X$ ($r^2 = 0.79$) and $\hat{Y} = 2.8120 + 0.000248X$ ($r^2 = 1.00$), respectively. No effect was observed ($P > 0.05$) of the dietary energy levels on weight gain and intakes of diet and protein in both thermal environments.

Daily weight gain (DWG) and daily FI were, respectively, 8.1 and 7.7% lower ($P < 0.02$) for gilts kept under heat stress.

Table 2
Growth, feed and nutrient intake of gilts from 15 to 30 kg at different environmental temperatures^a

Item	Digestible energy level (kcal/kg) at 22°C						Digestible energy level (kcal/kg) at 32°C					
	13.40	14.03	14.65	15.28	15.91	\bar{X}	13.40	14.03	14.65	15.28	15.91	\bar{X}
Weight gain (g day ⁻¹)	633	638	668	658	662	652 A	577	607	628	579	583	595 B
Feed intake (g day ⁻¹)	1278	1243	1333	1226	1223	1261 A	1172	1206	1215	1100	1093	1157 B
Feed : gain ratio (g g ⁻¹)	2.02	1.96	2.00	1.86	1.85	1.94 A	2.03	1.99	1.95	1.91	1.88	1.95 B
DE intake (MJ day ⁻¹)	4089	4165	4666	4477	4647	4408 A	3752	4040	4251	4014	4152	4042 B
Protein intake (g day ⁻¹)	249	242	260	239	238	246 A	229	235	237	215	213	226 B

^a Means followed by different capital letters within a row are different ($P < 0.01$) by the F test.

FC ratio of gilts in the two environments (thermal comfort and heat stress) not differ ($P > 0.05$), showing that DWG was reduced due to a lower FI.

Environmental temperature influenced ($P < 0.01$) the fasting weight/live weight (FW/LW) and the carcass weight/fasting weight (CW/WF) ratios (Table 3) which were, respectively, 1.58 and 3.56% greater in the gilts kept under heat stress.

The dietary DE level influenced ($P < 0.04$) only the FW/LW ratio that linearly increased in heat stress environment according to the regression $\hat{Y} = 81.3205 + 0.00349X$ ($r^2 = 0.69$).

As regards to the fat deposition rate (FDR) in the carcass it was observed that gilts kept under heat stress had FDR 13% lower than those kept in thermal comfort (Table 3). However, the protein deposition rate (PDR) was not influenced by environmental temperature.

The protein deposition rate was not influenced ($P > 0.10$) by the DE level in the thermal comfort environment, but it increased ($P < 0.04$) up to the level of 3440 kcal (14.40 MJ) in the heat stress environment according to the regression $\hat{Y} = -980.093 + 0.61889X - 0.00008995X^2$ ($r^2 = 0.69$). With relationship to the fat deposition rate, a crescent linear effect was verified with the increase of dietary energy level in comfort ($P < 0.04$) and heat stress ($P < 0.08$) environments according to the regressions $\hat{Y} = -69.7028 + 0.06024X$ ($r^2 = 0.75$) and $\hat{Y} = -52.9777 + 0.05047X$ ($r^2 = 0.89$), respectively.

Environmental temperature influenced ($P < 0.01$) the absolute and relative weights of all organ evaluated (Table 4), with gilts kept at heat stress having lighter organs. The reduction ranged from 11.2% (heart) to 17.6% (liver) in absolute weight term and from 16.4% (heart) to 22.3% (liver) in relative weight.

No effect was observed of the dietary DE level on the absolute and relative weights of the different evaluated organs in the thermal comfort environment except for absolute and relative weight of kidneys that linearly increased ($P < 0.07$) according to the regressions $\hat{Y} = 257.572 - 0.03173X$ ($r^2 = 0.73$) and $\hat{Y} = 1.2123 - 0.0001417X$ ($r^2 = 0.60$), respectively. However, in the heat stress environment a crescent linear effect of the energy levels on the liver ($P < 0.02$) and heart ($P < 0.09$) absolute weights occurred according to the regressions $\hat{Y} = 173.687 + 0.11827X$ ($r^2 = 0.96$) and $\hat{Y} = 50.7683 + 0.01618X$ ($r^2 = 0.91$), respectively. There was no effect of dietary energy levels on absolute and relative weights from other evaluated organs in heat stress environment.

As regards thyroid hormones (Table 5) it was observed that gilts exposed to a heat stress had lower ($P < 0.01$) blood serum concentration of total tri-iodothyronine (T_3) and total Thyroxine (T_4).

The dietary energy levels influenced the total serum blood concentration of T_3 ($P < 0.02$) of the gilts kept in the thermal comfort and of free T_3 ($P < 0.09$) of those kept in heat stress environments that increased linearly according to the regressions $\hat{Y} = -70.5206 + 0.0619X$ ($r^2 = 0.99$) and $\hat{Y} = 1.24167 + 0.001347X$ ($r^2 = 0.75$), respectively. The dietary energy level did not influence the blood serum concentration of total thyroxine (T_4).

As regards physiological parameters (Table 5) there was no significant difference in body temperature between the two environments. Maintenance of body temperature under thermal stress was possible because of the increase ($P < 0.01$) in the respiratory rate, which was 36.2% higher than that observed in the animals under thermal comfort.

Table 3

Fasting weight/live weight (FW/LW) and carcass weight/fasting weight (CW/FW) ratios and protein and fat deposition rates in carcass of gilts from 15 to 30 kg at different environmental temperatures^a

Item	Digestible energy level (kcal/kg) at 22°C						Digestible energy level (kcal/kg) at 32°C					
	13.40	14.03	14.65	15.28	15.91	\bar{X}	13.40	14.03	14.65	15.28	15.91	\bar{X}
FW/LW Ratio (kg kg ⁻¹)	91	91	92	93	92	92 A	92	93	94	94	94	94 B
CW/FW Ratio (kg kg ⁻¹)	74	75	75	75	75	75 A	77	78	77	78	78	78 B
Accretion Rate on Carcass (g day ⁻¹)												
Protein	77	79	81	78	77	78 A	78	85	87	76	75	80 A
Fat	124	122	154	150	156	141 A	103	121	127	133	135	124 B

^a Means followed by different capital letters within a row are different ($P < 0.01$) by the F test.

Table 4

Absolute and relative weights of liver, kidneys, heart and lungs in 30 kg gilts at different environmental temperatures^a

Item	Digestible energy level (kcal/kg) at 22°C						Digestible energy level (kcal/kg) at 32°C					
	13.40	14.03	14.65	15.28	15.91	\bar{X}	13.40	14.03	14.65	15.28	15.91	\bar{X}
Absolute weight (g)												
Liver	716	709	671	687	696	696 A	556	567	587	598	629	588 B
Kidneys	159	148	142	148	136	146 A	127	127	134	130	142	132 B
Heart	123	124	125	122	122	123 A	102	107	106	109	113	107 B
Lungs	274	258	249	255	253	258 A	208	228	221	226	229	222 B
Relative weight (%)												
Liver	3.54	3.43	3.22	3.39	3.36	3.39 A	2.68	2.66	2.66	2.66	2.74	2.68 B
Kidneys	0.78	0.71	0.69	0.72	0.67	0.72 A	0.60	0.60	0.61	0.58	0.64	0.61 B
Heart	0.61	0.60	0.60	0.60	0.59	0.60 A	0.49	0.50	0.48	0.49	0.51	0.49 B
Lungs	1.33	1.26	1.16	1.25	1.21	1.24 A	1.00	1.07	1.00	1.00	1.03	1.02 B

^a Means followed by different capital letters within a row are different ($P < 0.01$) by the F test.

4. Discussion

Stahly and Cromwell (1979), Nienaber et al. (1987), Dividich and Noblet (1986), Stahly and Cromwell (1986), Lopez et al. (1991) and Schenck et al. (1992) also observed reductions in weight gain and FI by swine due to high-temperature environment. Several authors quoted by Fialho (1994) reported that at high temperatures swine reduce their FI and, consequently, their weight gain, as a means of reducing heat output from digestive and metabolic processes. According to Verstegen and De Greef (1992), swine respond to temperature variation by changes in FI and/or changes in heat loss.

The improvement observed in the FC ratio in both thermal environments is justified by the progressive reduction in the caloric increment of the diets with the inclusion of the soybean oil. Just (1982), Coffey et al. (1982) and Schoenherr et al. (1986) have evidenced benefit of the fat addition to the diets due to its smallest caloric increment. Stahly and Cromwell (1979) verified that the reduced caloric increment of a diet supplemented with fat resulted on higher percentage of feed being available for tissue synthesis by animals kept in thermal comfort or heat stress environments.

The fact of the animals, in both environments, have presented similar results of FC ratio (Table 2) in this study confirm those data from Dividich and Noblet (1986) and Stahly and Cromwell (1986) in their studies with weaned and growing swine, respectively. However, they conflict with the results of Nienaber et al. (1987), Christon (1988), Lopez et al. (1991) and Schenck et al. (1992), who found a worsening in the efficiency of feed utilization by swine at various stages of growth because of high environmental temperature. Among several things, the feed level and animals genotype used could have contributed to the differences in the results among the studies.

Since the diets used in both environments had the same levels of DEI (13.40, 14.06, 14.65, 15.28 and 15.91 MJ DE diet kg⁻¹), and were isoproteic (19.5%), the differences in food intake resulted in differences in DEI and PI, with the animals kept at 32°C consuming less.

Table 5
Blood serum concentrations of thyroid hormones and physiological parameters in 30 kg gilts at different environmental temperatures^a

Item	Digestible energy level (kcal/kg) at 22°C						Digestible energy level (kcal/kg) at 32°C					
	13.40	14.03	14.65	15.28	15.91	\bar{X}	13.40	14.03	14.65	15.28	15.91	\bar{X}
Hormonal parameters												
Total T3 (ng ml ⁻¹)	126.8	136.8	148.6	154.1	164.6	146.7 B	163.8	156.0	160.5	176.8	170.5	165.3 A
Free T3 (pmol l ⁻¹)	4.4	4.5	4.3	4.7	4.8	4.5 A	3.2	3.2	3.3	3.9	3.8	3.4 B
Total T4 (µg dl ⁻¹)	13.1	13.7	12.2	12.3	12.7	12.9 A	9.7	10.4	9.8	10.6	10.1	10.1 B
Physiological parameters												
Respiratory rate (mov min ⁻¹)	40	40	40	40	40	40 A	40	40	40	40	40	40 A
Rectal temperature (°C)	49	45	48	50	43	47 B	65	67	60	67	63	64 A

^a Means followed by different capital letters within a row are different ($P < 0.01$) by the F test.

The obtained results reinforce previous reports that reductions in growth rate found in animals exposed to high temperatures occurred because of reductions in diet intake.

As regards the FW/LW and CW/LW ratios (Table 3) it was observed that the higher FW/LW ratio saw in gilts kept at 32°C to be related to a lower content of digest in the gastrointestinal tract. This lower content can be due the lowest physical capacity of both intestines that have its sizes reduced in environment of high temperature (Dauncey et al., 1983). Evaluating male broilers from 22 to 42 days feeding pair diet in thermal comfort (22°C) and heat stress (32°C) environments, Oliveira Neto et al. (1998) observed reduction in intestines weight with increase of environmental temperature. The greater CW/FW reflects the lower weights of the organs evaluated (Table 4) and, probably also, of the gastrointestinal tract (Dauncey et al., 1983). Working with gilts from 20 to 45 kg, Bikker et al. (1995) observed a reduction from 84 to 81% in carcass weight in relation to fasting weight, because of the increase in organs weight from 16 to 19%.

The increase in the protein deposition rate observed in the heat stress environment up to the 14.40 MJ DE level be more related to the increase in the energy intake than to the PI. That affirmative is based on the fact that the observed PI up to the 14.65 MJ level changed at only 8 g. The decrease in the PI in the two higher studied energy level justifies the reduction in the protein deposition rate in those levels.

The results of the higher CW/FW ratio (Table 3) might help to explain why the gilts exposed to higher temperature showed similar protein deposition rate (PDR) on carcass ($P > 0.10$) to those exposed to 22°C, in spite of differences in daily PI.

As high protein and lysine levels in the diets were used, the change in the diet intake between the environments was not enough to influence the protein deposition rate in the carcass. On the other hand, the energy intake seemed to exceed the maximum demand for protein retention that resulted in differentiated fat deposition rates in accordance with the energy intake in each environment. According to Bikker and Bosh (1996) the dietary energy intake above that required for maximum protein deposition is used for fat deposition.

Evaluating the influence of energy intake on the deposition of protein and lipids in the body components of gilts from 20 to 45 kg, Bikker et al. (1995) observed an increase in organ weights, with the consequent increase in the proportion of body protein deposited in these organs.

The linear increase observed in the fat deposition rate in the animal carcasses kept in the thermal comfort or in the heat stress environments occurred as a direct action of the energy intake. Those results are in accordance with those observed by Bikker et al. (1995).

According to Fialho and Cline (1991) energy retention by the animal is reduced at high environmental temperature. The higher DEI intake by gilts kept under thermal comfort explains this result. Such results confirm those obtained by Campbell and Taverner (1988), Kyriazakis and Emmans (1992) and De Greef et al. (1994).

The results of performance and carcass composition obtained in this study agree with the conclusion by Steinbach (1987) about the effects of tropical climate on swine physiology and productivity. While the growth rate was significantly reduced at high temperature, the efficiency of nutrient conversion and the carcass values are not affected or they may, indeed, be slightly improved.

Several authors, among them Stamataris et al. (1991), Rao and McCracken (1992) and Bikker et al. (1995), have observed reductions in organ size associated with variations in energy intake exceeding 15%. Since in this work the difference in energy intake corresponded to 9.1%, it may be inferred that probably temperature was the major factor responsible for the variation observed in organ weight.

In the present trial the blood serum concentrations of thyroid hormones were influenced by the environmental temperature, being lower for the higher environmental temperature. Reduction in the blood serum levels of T₃ and T₄ because of high temperature has been observed in swine (Christon, 1988; Fialho, 1994) and poultry (May, 1978, quoted by May and Reece, 1986; McNaab, 1995).

The reduction in thyroid hormone concentrations, reduces the activity of the Na⁺, K⁺ and ATPase (sodium pump) enzyme (Himms-Hagen, 1983, quoted by Takeuchi et al., 1995), decreasing the energy spent by the tissues (Ismail-Beigi and Edelman, 1970, quoted by Baldwin and Bywater, 1984). The lower weight of metabolically active organs such as the liver, kidneys and intestine, responsible for the greater proportion of total swine heat output (Koong et al., 1983), contributed significantly to the saving in energy. Considering both statements above may be inferred that despite the energy spent to dissipate body heat (Close and Mount, 1978), the maintenance requirement for gilts kept at a 32°C temperature may possibly be lower than the requirement for those kept in thermal comfort.

Association between reduction in maintenance requirement and decrease in inner organ mass, in addition to a reduction in the metabolic activity of these organs, has been observed with growing mice by Koong et al. (1983) and by Ferrell and Koong (1986). Campbell and Taverner (1988) reported that maintenance energy requirement of piglets from 9 to 20 kg may decline as environmental temperature increases up to 32°C.

During this study the animals maintained their body temperature. However, respiratory rate increased at those animals kept at higher temperature. These observations point out the importance of animal breathing in heat dissipation, since in swine the loss of heat by the sweat glands is limited. The increase in respiratory rate is one of the major mechanisms for heat loss in swine (Ames, 1982, quoted by Lopez et al., 1991; Fialho, 1994) striving to maintain their body temperature. Working, respectively, with swine at growth and finishing, Christon (1988) and Lopez et al. (1991) found that respiratory rate increased because of high environmental temperature, while rectal temperature did not change.

5. Conclusions

The environmental temperature influenced organs weight that were lower in animals kept under high environmental temperature.

The heat stress resulted in change of the composition of the gain of the animals reducing the fat deposition rate on the carcass and consequently on weight gain.

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