SOME PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF NORMAL AND STRESS-PRONE PIGS

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SUMMARY

The purpose of this study was to evaluate known genetic lines of stress-prone and non stress-prone swine for plasma cortisol, growth hormone, glucose, lactate, Na, K and Cl. Also, daily secretory rhythms for these substances were evaluated. A significant decrease in plasma cortisol and growth hormone occurred from 8:00 a.m. to 4:00 p.m. All three electrolytes were lowest at the p.m. collection time and K had a significant decrease. A litter response was observed for both cortisol and growth hormone and a significant interaction existed. Two patterns were observed for plasma cortisol from stress-prone swine. One group had very high levels and the other low levels after a stress period. Plasma lactate increased in all groups after stress, but a greater increase occurred in the stress-prone pigs when compared to controls. No significant differences existed between pigs studied for M.longissimus color. Muscle color doesn't appear to be a good method to separate stress-prone from non stress-prone pigs in a selection program. Known sample collection time and genotype of pigs used for studies on hormone function appears important in the evaluation of physiological treatments.

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Introduction

Intensive genetic selection for muscle deposition in swine has also altered certain physiological adaptation mechanisms causing some pigs to be highly sensitive to sudden changes in their environment. Extreme animals will often die when subjected to environmental stressors and several theories have been postulated as to the cause of death. Bugard, Henry and Houbert (1962) suggested that uncoupling of the oxidative phosphorylation was one of the main causes of the higher sensitivity of these pigs to stress. Topel et al (1968) and Muylle et al (1968) considered blood acidosis to be one of the main factors associated with this abnormal condition. Sybesma and Eikelenboom (1969) pointed out the importance of hyperthermia and Lister et al (1970) reported an anoxia condition was associated with the unusual traits of stress prone swine.

Experimental Procedure

This report includes data from two experiments. The first experiment studied daily rhythms at 8:00 a.m. and 4:30 p.m. for plasma cortisol, growth hormone, glucose, lactate, Na, K and Cl. Eight, 91 kg pigs were used in this portion of the study and blood samples were collected from an indwelling catheter in the dorsal aorta. The second experiment compared litters (three normal and three stress-prone) of genetically selected pigs (91 kg) for the same characteristics listed for experiment one. Also, M. longissimus color and Ph were evaluated. Animals in experiment 2 were catherized in the vena cava for blood sample collection. Cortisol was determined by the protein binding method reported by Whipp and Lyons (1970), growth hormone procedure involved the radio-immuno assay as modified by Siers (1968), procedures for glucose, lactate, Na, K, and Cl were modifications reported by Technicon, 1960, for use with the auto-analyzer. Muscle pH was determined with a Beckman Ph meter and muscle color with a Photovolt reflectance meter.

Results and Discussion

Experiment I

The daily rhythms observed for the characteristics studied are shown in table 1. Cortisol levels decreased from 8:00 a.m. to 4:00 p.m. Considerable fluctuation occurred in cortisol levels both between animals and during sample collection times. This is in agreement with the results reported by Steinhauf et al (1969). Analysis for growth hormone indicates that time of sample collection was an important factor in altering circulating levels. The highest levels occurred at 8:00 a.m. and significantly decreased at 4:00 p.m. Further samples collected at 8:00 p.m. were significantly lower (9.4 mμg/ml) than the 4:00 p.m. values.

Table 1. Daily rhythms of 91 kg pigs for plasma cortisol, growth hormone, glucose, lactate, sodium, potassium and chloride.

Time	8:00 a.m.	4:00 p.m.
Cortisol, μg%	6.92	5.62*
Growth hormone, mμg/ml	11.3	10.6*
Glucose, mg%	83.8	87.2
Lactate, mg%	2.0	1.6
Sodium, meg/l	137.5	134.5
Potassium, meg/l	98.8	93.2*
Chloride, meg/l	5.3	4.9

* Significant at (P<.05)

Glucose levels increased from 8:00 a.m. to 4:00 p.m. and the plasma lactate values decreased slightly but the differences were not significant. All three electrolytes were lowest at the p.m. collection time, and K had a significant decrease. This variation implicates the importance of uniform sample collection time for these substances in experimental work.

Experiment II

The influence of genotype and stress on pigs from the litters studied are shown in Table 2. A litter response occurred for cortisol levels and a significant interaction existed. Non-stress prone pigs show a relatively stable cortisol level irrespective of sample collection time and gave an elevated response during stress. Litters with stress prone traits (type I and II in table 2) had more erratic responses. Two extremes were observed in this study. The values for type I litters represent pigs which secreted extremely high levels of cortisol when they became excited and normal levels during non-excited conditions. The other extreme, type II litters, represent pigs that possessed lower cortisol levels and a small increase in cortisol occurred after stress. This suggests that genetic lines vary in their ability to react to stress for levels of plasma cortisol and pigs showing signs of the stress syndrome (Topel et al, 1968) can have different patterns of plasma cortisol. Marple (1970) reported that stress prone swine have significantly higher levels of plasma ACTH irrespective of plasma cortisol levels. Some stress-prone pigs in Marples' study had elevated levels and others had lower levels of plasma cortisol. These data further suggest an imblanace in the function of the adrenal-pituitary axis in the stress-prone pig.

Table 2. Influence of genotype and stress on plasma cortisol, growth hormone, glucose, lactate, Na, K and Cl.

	Non stress-prone litters		Stress-prone litters			
			Type I		Type II	
	Before stress	After stress	Before stress	After stress	Before stress	After str
Cortisol[a,b], µg%	6.05	8.8	7.45	11.05	2.8	4.33
Growth Hormone[b] mµg/ml	10.82	10.81	9.30	8.79	7.79	7.31
Glucose[b], mg%	84.0	107.3	85.0	157.2	87.2	120.4
Lactate[b], mg%	1.59	10.2	1.73	19.25	1.44	17.0
K[b], meg/l	97.4	103.9	102.4	108.4	96.7	105.3
Cl, meg/l	4.92	5.38	4.75	4.17	4.59	5.25
Na, meg/l	140.9	146.6	137.4	137.0	140.4	136.0

[a]Significant ($P<.05$) litter interaction.

[b]Significant ($P<.05$) response from stress for all groups.

Analysis for growth hormone indicates that a significant litter response was obtained when daily samples were collected. No significant differences between controlsand stress prone pigs were observed before or after stress conditions. No significant differences in growth hormone were obtained from five minutes of physical stress. This suggests that intensity and kind of stress is largely independent of the levels of plasma growth hormone in the pig.

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Plasma glucose and lactate values were similar for samples collected before stress, but significantly increased for all pigs after stress. The stress prone pigs had higher lactate and glucose values after stress than the controls and the type I, stress prone pigs had very elevated plasma glucose values after stress. This may be associated with the higher cortisol levels from these pigs. No significant differences in Na, Cl, or K values from samples collected before stress occurred for pigs compared in table 2. Potassium levels increased after stress and the highest elevation was in the stress prone groups. The Na and Cl values obtained after stress showed a non significant response for all groups of pigs compared in the study.

The direct influence of genotype upon the predisposition of swine to stress and some physiological characteristics associated with stress adaptation are further supported from these studies. Recent work by Weiss(1971) also shows that genetic lines of fat type pigs have significantly lower levels of plasma cortisol and epinephrine when compared to meat type pigs from known genetic lines of stress prone pigs. The importance of known genotype appears important when physiological characteristics are studied.

Table 3 shows M. longissimus pH and color traits from pigs studied in experiment II. Stress prone pigs had significantly lower M. longissimus pH values

Table 3. M. longissimus color[a] and pH values.

Time Post Mortem	Non-stress-prone litters		Stress prone litters Type I		Stress prone litters Type II	
	pH[b]	color	pH	color	pH	color
30 minutes	6.44	11.8	6.16	10.3	6.25	12.5
24 hours	5.69	19.8	5.40	18.7	5.27	22.1

[a]Expressed as reflectance with the higher values indicating a lighter color.

[b]Muscle pH from stress prone animals are significantly ($P<.05$) lower than non stress-prone pigs for each group.

than the non stress-prone control pigs, but no major difference existed for muscle color, 24 hour postmortem. The type II stress-prone pigs exhibited the lightest color but considerable variation in muscle color occurred between individual pigs in the stress prone groups. Muscle color doesn't appear to be a good method to separate stress-prone from non stress-prone animals in a selection program.

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