EFFECT OF FEED INTAKE AND ENVIRONMENTAL TEMPERATURE ON GROWTH AND CARCASS TRAITS OF BROILERS

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Story in Brief

Four-week old broiler chicks were reared under three environmental temperatures: cold (C,7.2C) hot (H,35C) and thermoneutral (TN,23.9C) for two weeks and force-fed to intake levels approximating 69, 88, 103 and 116 percent of TN controls consuming feed ad libitum. Controls in C and H environments exhibited reduced body weight gain, feed efficiency, dry matter digestibility and carcass weight. Birds housed within the C environment exhibited greater feed intake as a percentage of body weight ;(29,42 percent) and yielded less abdominal fat (86,80 percent) than birds housed in TN or H environments, respectively. Increasing feed consumption above ad libitum intakes within an environmental temperature by force-feeding increased carcass gain only in the H environment. Gastrointestinal tract mass and abdominal fat increased with feed intake across temperature. Feed efficiency and ration digestibility declined with increasing feed intake within the H and TN environments but improved quadratically with feed intake in the C environment. The data reported indicate that feed intake limits carcass weight gain of poultry reared under heat stressed conditions.

Introduction

Environmental factors such as ambient temperature, relative humidity, light duration and intensity, air movement and population density, are recognized as having a major impact upon production of meat from broiler chicks. Environmental temperature is foremost among these in its deleterious effects upon Oklahoma broiler production because it reduces feed intake and yet increases the birds maintenance requirements. Growth rate is depressed at post-brooding temperatures above 23 C and feed efficiency below 21 C.

The studies reported herein were conducted to determine if feed intake limits body weight gain and carcass yield of edible parts in commercial broiler chicks reared under cold, thermoneutral and heat stress environments.

Materials and Methods

Seventy 4 week old chicks (Arbor Acre x Lancet) were assigned at random to individual cages within each of three environmental chambers. Birds were adapted to chamber surroundings and the environmental temperature deviated

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from 23.9 C in 2.8 C per day increments during a one week adjustment period till the desired temperatures were reached: C (7.2 C), TN (23.9 C) and H (35 C). Twenty birds per chamber were designated as controls and allowed to consume feed ad libitum while the remainder were assigned to force feeding intake levels approximating 69, 88, 103 and 116 percent of control ad libitum consumption. The force feeding method used has been previously described (Teeter, et al., 1984). The experimental ration (Table 1) was mixed with water in a 45:55 ratio for force feeding at six-hour intervals. Birds were weighed every three days and the amount of ration adjusted accordingly to provide the specific feed intake level. Upon completion of the 14-day feeding study, following an overnight fast, birds were weighed and processed using an automated processing system. Carcass yield of breast, thigh, drumstick and abdominal fat were estimated by hand seperating the carcass into these fractions.

Table 1. Ration composition.

Ingredient	IFN[a]	%
Ground corn	4-02-935	45.15
Soybean meal	5-04-604	39.19
Corn oil	4-07-882	10.00
Dicalcium phosphate	6-01-080	2.38
Calcium carbonate	6-01-069	.89
Salt	6-14-013	.40
Vitamin premix[b]		.40
Cr_2O_3[c]		.30
Dl-methionine	5-03-086	.19
Trace mineralized salt		.10
Total		100.00

[a]International feed number

[b]Chemical Division Hoffman-LaRoche, Inc. Nutley, NJ. 07410

Results and Discussion

Body weight gain, carcass gain, feed efficiency and ration digestibility for birds consuming feed ad libitum at the three environmental temperatures are presented in Table 2. Birds reared at 7.2 C consumed 28 and 45 percent more feed as a percentage of their body weight per day than those in the thermoneutral and hot environments, respectively. Birds in the H and C environments exhibited reduced body weight gain (43 and 26 percent) and decreased carcass gain (34 and 36 percent). The adverse environmental conditions reduced feed efficiency by 29 and 21 for the cold and hot environments, respectively in

Table 2. Intake, ration digestibility, body weight gain, carcass gain and feed efficiency of birds consuming feed ad libitum.

	7.2C	23.9C	35C
Intake (% body wt/day)	12.1^{a}	9.4^{b}	8.5^{c}
Ration digestibility (%)	68.6^{a}	73.8^{b}	72.0^{b}
Body weight gain (g)	499^{b}	675^{a}	386^{c}
Carcass gain (g)	362^{b}	549^{a}	339^{b}
Body wt gain/feed	$.42^{b}$	$.61^{a}$	$.48^{b}$

^{abc}Means within a row with unlike superscripts differ ($P<.05$).

contrast to the TN. The deleterious effects of environmental stress upon feed efficiency is due in part to the bird's increased maintenance requirements though ration digestibility declined by a mean of 6 percent.

Increasing feed consumption within the TN and C environment by force-feeding resulted in increased live weight gain (Table 3) to the level of ad libitum consumption, but failed to elicit a significant response above this level though feed consumption increased 15 percent. Other experiments conducted in our laboratory, where feed intake was increased to 60 percent above ad libitum consumption levels, failed to elicit a carcass gain response though live body weight and empty gastrointestinal tract weight increased dramatically. However, under heat stress conditions, increasing feed consumption above heat stress control increased carcass gain by a mean of 21 percent. Feed efficiency (Table 4) was not affected by feed intake within the thermoneutral and hot environments, but increased quadratically within the cold environment. Dry matter digestibility (Table 4) was inversely correlated ($R= -.18$) with feed intake in the thermoneutral and hot environments with values at the 11.1 percent feed intake level lower than at the 6.5 percent feed intake. Dry matter digestibility in the Cold environment was lower ($P<.05$) than corresponding feed intake levels at the higher temperatures. There was a sharp decline in digestibility across temperature when ad libitum consumption was exceeded.

Weight of carcass parts indicated that birds reared under thermoneutral conditions produced heavier drumsticks, thighs and breasts than those reared under cold and hot temperature conditions. Increasing feed intake above ad libitum consumption, by force-feeding resulted in increased weights of carcass parts only in the H environment while adominal fat weight increased with feed intake across temperatures. However, birds reared in the cold environment, likely as a result of their increased maintenance requirements, deposited less fat than those in the hot and thermoneutral environments.

Table 3. Live gain and carcass gain for force-fed birds at three temperatures.

Intake (% body wt per day)	7.2C		23.9C		35C	
	Live gain	Carcass gain	Live gain	Carcass gain	Live gain	Carcass gain
6.5	-37.6^{h}	-3.4^{i}	319.1^{f}	271.1^{def}	304.3^{f}	246.3^{ef}
8.3	140.1^{g}	106.3^{h}	534.0^{e}	439.7^{bc}	419.3^{def}	335.9^{cde}
9.6	192.9^{g}	147.4^{gh}	651.6^{ab}	517.4^{ab}	557.8^{bc}	403.8^{c}
11.1	377.9^{ef}	272.9^{def}	709.0^{a}	546^{a}	490.6^{cde}	348.6^{cde}
12.9	314.5^{f}	207.7^{fg}	--	--	--	--
Pooled SEM	121.3	106.12				

^{a,b,c,d,e,f,g,h,i}Means in gain designation across temperatures having different superscripts differ (P<.05)

Table 4. Feed efficiency, carcass efficiency and ration digestibility of force-fed birds at three temperatures.

	7.2 C			23.9 C			35 C		
(% body wt/day)	Live gain per feed	Car. gain per feed	Dig.	Live gain per feed	Car. gain per feed	Dig.	Live gain per feed	Car. gain per feed	;.
6.5	$-.08^{g}$	$-.0006^{e}$	70.4^{def}	0.52^{abcd}	0.443^{a}	75.9^{a}	0.52^{abcd}	0.415^{ab}	76^{bc}
8.3	0.20^{f}	$.151^{d}$	70.7^{cdef}	0.58^{ab}	0.473^{a}	74.8^{ab}	0.54^{abc}	0.432^{a}	74^{cde}
9.6	0.25^{f}	$.198^{d}$	70.1^{def}	0.59^{a}	0.465^{a}	73.2^{abcd}	0.56^{abc}	0.405^{ab}	71^{g}
11.1	0.38^{e}	0.284^{c}	70.4^{def}	0.57^{abc}	0.433^{a}	71.5^{acde}	0.46^{cde}	0.331^{bc}	
12.9	0.29^{f}	0.191^{d}	65.4^{g}	--	--	--	--	--	
Pooled SEM	0.107	0.094	3.32						

^{abcdefg}Means in value designation across temperatures having different superscripts differ (P>.05).

The data from this experiment permits a comparison of the effect of increased feed intake on broiler performance at temperatures above, within and below the zone of thermoneutrality. In this experiment, maximum production in the cold and thermoneutral environments is achieved at or about ad libitum intake level, while in the hot environment, increasing feed intake to levels above normal consumption resulted in increased productivity. It appears that the modern broiler chicks, genetically selected for rapid growth rates and hence large feed consumption, growth rate is limited by feed consumption only when high environmental temperatures reduces feed intake. Biological factors that influence feed intake in hot environment need to be studied.

Literature Cited

Teeter,R.G., et al. 1984. Poultry Sci. 63:573-575.