EFFECT OF SUPPLEMENTATION AND PARASITIC INFECTION ON PRODUCTIVITY OF THAI NATIVE AND CROSS-BRED FEMALE WEANER GOATS
Ⅱ. BODY COMPOSITION AND SENSORY CHARACTERISTICS

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Summary

This paper presents results from a study of the body composition and sensory characteristics of female weaner goat meat. A completely randomized 3 × 3 × 2 factorial design was used. Factors were genotype (Thai native; TN, 75% TN × 25% Anglo-Nubian; AN and 50% TN × 50% AN), feeding (grazing only, low (1.0% BW/d) and high (1.5% BW/d) concentrate supplementation and parasite control (undrenched and drenched)). It was shown that there was no effect of genotype on body components and dressing percentage. However, TN and 75% TN × 25% AN kids had significantly ($p < 0.05$) higher muscle to bone ratios (4.20% and 4.20%, respectively) compared with 50% TN × 50% AN kids (3.88%). Kids on grazing only had significantly ($p < 0.01$) higher muscle percentage (64.12%) than did kids in low (61.30%) and high (60.62%) supplementary feeding program, but there was no significant ($p > 0.05$) difference between low and high supplementary feeding groups. Kids offered supplementary feeding had significantly ($p < 0.01$) higher percentages of total fat, intermuscular fat, pelvic fat and kidney fat than those of grazing only. Kids offered supplementary feeding had significantly ($p < 0.05$) higher muscle to bone ratios and significantly ($p < 0.01$) higher muscle plus fat to bone ratios compared with those of grazing only. This may be due to significantly lower ($p<0.01$) bone contents (14.95, 14.17 and 16.8% for kids offered low and high supplementary feeding and grazing only, respectively. There was no significant difference in sensory characteristics of goat meat between genotypes or feeding groups.

(Key Words: Thai Native Goat, Anglo-Nubian Cross-bred Goat, Feed Supplementation, Parasite, Red Meat, Goat Meat, Meat Flavour)

Introduction

There are many factors influencing the growth of goats: genotype, sex, age and weight, physiological stage, nutrition and environment, for example. It was demonstrated that Thai native goats had significantly higher growth rates than did the cross-bred in the second period of the experiment. Growth rate of goats grazing improved pasture depended upon amount of concentrate supplementation (Pralomkarn et al., 1994). There are some studies on the effects of Thai goat genotype and feeding level on body composition of male goats under feedlot conditions (Pralomkarn et al., 1993a; Pralomkarn et al., 1993b). However, there is no information available on genotype or level of supplementation on the body composition of goats grazing on pasture. Accordingly, the following study was designed to investigate the effect of genotype and levels of supplementary feeding on body composition and sensory characteristics of the meat of female goats grazing improved pastures.

Materials and Methods

Location and climate were described by Pralomkarn et al. (1994).

Experimental animals

Thirty-six kids were allocated in 3 × 3 × 2 factorial design with 2 kids per treatment. The factors were genotypes of goat (Thai native; TN, 75% TN × 25% Anglo-Nubian; AN and 50% TN × 50% AN goats), feeding (grazing only, low (1.0% BW/d) and high (1.5% BW/d) supplementation and parasite control (undrenched and drenched). This flock of goats was obtained from the study of effect of supplementation and parasitic infection

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Received December 23, 1993
Accepted July 19, 1994

on growth of Thai native and cross-bred female weaner goats (Pralomkarn et al., 1994).

For sensory analysis, only goats from parasite controlled group were used (8 TN, 7 75% TN × 25% AN and 8 50% TN × 50% AN).

Slaughter and dissection method

After growth experiment, 36 kids were deprived of feed overnight and were weighed individually and slaughtered by exsanguination the following day and reweighed after bleeding. All organs were weighed to the nearest gram in the following order: head, feet, skin, tail, full intestinal tract, empty intestinal tract (oesophagus, reticulo-rumen, omasum, abomasum, pancreas, caecum, small and large intestine, rectum and bladder), liver, lungs and trachea, heart, kidneys, spleen, diaphragm, repro ductive organ (uterus plus ovary) and carcass. The carcass was longitudinally divided into two parts and the right half was weighed (hot carcass weight). The carcasses were stored in polyethylene bags at −18℃ pending dissecting and sensory analysis. Left halves of carcasses were dissected into muscle, fat, bone and connective tissue. During dissection carcass fat was separated into subcutaneous, intermuscular, perinephric (kidney) and pelvic fat. Right halves of carcasses were used for sensory analysis.

Sensory analysis

Right halves of the frozen carcasses were used for sensory analysis. The carcasses were thawed in a 4℃ cold room for 24 h. Samples of ground meat, using lean muscle of hind quarter from each animal were prepared. Samples were daily grinding through a Kenwood meat grinder. The ground meat sample from each carcass was thoroughly mixed once to obtain a homogenous mixture. Four hundred grams of meat sample was placed in a 600 ml beaker, covered with watch glass and cooked in a microwave oven on setting of high for 7 minutes.

The sensory analysis was performed using the Quantitative Descriptive Attribute (QDA) method (Stone et al., 1974). The sensory panel consisted of seven trained panellists. A continuous non-structured scale was used for evaluation. A 10 centimetre line anchored on the left side with lowest intensity of each attribute and the right side with highest intensity was given. The attributes evaluated were goaty and grassy for aroma and goaty, grassy, meaty, milky, bitter, sweet, metallic and cardboard for flavour and acceptability.

One tablespoon of cooked ground meat sample was immediately placed into small glasses. Each panellist was given cooked samples which were kept warm in a hot sand bath. Samples were served in random order. No replicates were performed.

Statistical analysis

Differences between treatments for weights, body components, dressing percentage, dissectible carcass fractions, meat to bone ratios and meat plus fat to bone ratios were examined by analysis of variance using SAS (1987).

Analysis of variance of the sensory characteristics of goat meat for the completely randomised design was performed on the data collected for the effects of genotypes and feeding levels using the SAS program (1987).

Results and Discussion

The effects of genotype on body composition

Mean squares from analysis of variance for body composition and for dissectible carcass fractions, meat (muscle) to bone ratios and meat plus fat to bone ratios are showed in table 1 and table 3, respectively. Table 2 and table 4 shows mean with standard error of the main effects for genotype, feeding and parasite on body composition. Genotype had no effect on body components and dressing percentage. There was no significant difference in muscle, total fat and bone contents between genotypes. However, Pralomkarn et al. (1993b) found that TN and 75% TN × 25% AN male weaner kids had significantly lower bone contents when compared with 50% TN × 50% AN kids. In this study, TN and 75% TN × 25 % AN kids had significantly higher meat to bone and meat plus fat to bone ratios compared with 50% TN × 50% AN kids. These results may be due to a significantly lower bone percentage for TN kids (Pralomkarn, 1990; Pralomkarn et al., 1993b). In this study, 50% TN × 50% AN kids tended to have higher bone contents (16.16%) compared with those of 75% TN × 25% AN (14.79%) and of TN (14.99%) kids.

It could be concluded that male and female TN kids had significantly higher meat to bone ratios compared with 50% TN × 50% AN kids. Care needs to be taken that these characteristics

TABLE 1. MEAN SQUARES FROM ANALYSIS OF VARIANCE FOR BODY COMPOSITION

Source	Genotype (G)	Feeding (F)	Parasite (P)	G × F	G × P	F × P	G × F × P	Error
Hot carcass weight	80311	124161*	0.267	12132	11132	6343	5388	32965
Gut contents	5.170	32.253*	30.843*	11.595	0.565	2.700	3.826	6.443
Body component								
Head + horn	0.019	1.142*	0.159	0.294	0.137	0.082	0.485	0.245
Hide	1.207	1.684	0.880	1.460	0.331	0.781	0.694	0.974
Intestinal tract	0.444	0.311	0.0005	0.021	0.089	0.019	0.354	0.158
Tail	0.0001	0.003	0.0001	0.001	0.001	0.001	0.001	0.001
Blood	1.332	2.053	0.808	0.467	0.095	0.440	0.210	0.671
Feet	0.059	0.410**	0.146	0.057	0.059	0.027	0.002	0.056
Liver	0.038	0.018	0.090	0.010	0.002	0.011	0.034	0.028
Lungs + trachea	0.010	0.016	0.003	0.003	0.002	0.001	0.011	0.007
Omental fat	0.125	7.227	0.661	0.615	0.524	0.017	0.096	0.455
Reproductive organs	0.012	0.00001	0.006	0.004	0.002	0.003	0.002	0.048
Spleen	0.002	0.002	0.002	0.001	0.0001	0.00003	0.001	0.017
Heart	0.008	0.0004	0.002	0.006	0.006	0.004	0.002	0.004
Diaphargm	0.005	0.018	0.003	0.0003	0.0003	0.006	0.003	0.006
Kidneys	0.001	0.007	0.002	0.002	0.002	0.00003	0.0008	0.001
Dressing percentage								
1	2.901	22.425**	2.769	4.267	1.033	0.678	4.035	2.356
2	0.287	3.775	2.972	3.178	1.045	1.066	2.750	1.725

* ($p < 0.05$), ** ($p < 0.01$).
1 (hot carcass weight/fasted live-weight) × 100.
2 (hot carcass weight/empty body weight) × 100.

are not lost in cross-breeding programs with introduced European goats.

The effects of supplementary feeding on body composition

There were some effects of genotype on body composition (table 2 and table 4). Kids on grazing only had significantly ($p < 0.05$) higher head plus horn percentages (8.34%) than did kids offered low and high supplementary feeding (7.89% and 7.75%, respectively). However, there was no significant difference between low and high supplementary feeding. Kids on grazing only had significantly ($p < 0.01$) higher feet percentages (3.03%) than did kids offered low supplementary feeding (2.77%) and high supplementary feeding (2.67%).

Kids on grazing only had significantly ($p < 0.01$) lower (43.8%) dressing percent (hot carcass/fasted live-weight) compared with those of low (45.5%) and high (46.5%) supplementary feeding. However, there was no significant difference in terms of hot carcass weight/empty body weight between the treatments. This may be due to a difference in gut contents. Kids on grazing only had significantly ($p < 0.05$) higher gut contents (20.0%) than did low (18.7%) and high (17.6%) supplementary feeding.

Kids grazing only had significantly higher muscle percentages (64.12%) than did low (61.30%) and high (60.62%) supplementary feeding. However, there was no significant difference between low and high supplementary feeding for muscle (%). There was no significant difference in fat percentages between supplementary feeding groups. However, kids offered supplementary feeding had significantly higher total fat, intermuscular fat, pelvic fat and kidney fat (%) compared with those of grazing only. Ash and Norton (1987) found that *ad lib.* feeding resulted in significantly more fat (18.1%) and less water (61.5%) in the empty body of Australian cashmere goats compared with restricted feeding (14.4% fat, 64.0% water)

TABLE 2. MEAN WITH STANDARD ERROR (± SE) OF THE MAIN EFFECTS FOR GENOTYPE, FEEDING AND PARASITE ON BODY COMPOSITION OF GOATS

Parameter	Genotype			Feeding			Parasite	
	Thai native (TN)	75% TN × 25% AN[1]	50% TN × 50% AN	Grazing Only	Supplementation Low	Supplementation High	Drenched	Undrenched
Fasted live weight (kg)	16.6 ±0.9	19.6 ±0.9	19.6 ±1.0	16.9 ±0.9	18.5 ±0.9	20.4 ±1.0	18.7 ±0.8	18.7 ±0.8
Hot carcass weight (kg)	7.5 ±0.8	9.0 ±0.8	8.8 ±0.3	7.4 ±0.7[a]	8.4 ±0.7[a]	9.5 ±0.5[b]	8.5 ±0.4	8.4 ±0.4
Gut contents (%)	19.3 ±0.7	18.3 ±0.7	19.6 ±0.7	20.9 ±0.7[a]	18.7 ±0.7[b]	17.6 ±0.8[b]	18.0 ±0.6[a]	20.0 ±0.6[b]
Body component (%)								
Head + horn	7.95±0.14	8.01±0.14	8.03±0.15	8.34±0.15[a]	7.89±0.14[b]	7.75±0.15[b]	8.06±0.12	7.93±0.12
Hide	8.36±0.28	8.32±0.28	7.77±0.30	8.47±0.28	7.74±0.28	8.23±0.31	8.31±0.24	7.99±0.23
Intestinal tract	7.82±0.11	7.48±0.11	7.48±0.12	7.41±0.11	7.71±0.11	7.66±0.12	7.60±0.10	7.59±0.10
Tail	0.17±0.01	0.17±0.01	0.17±0.01	0.17±0.01	0.19±0.01	0.16±0.01	0.18±0.01	0.17±0.01
Blood	2.59±0.24	3.19±0.24	3.17±0.25	2.72±0.23[a]	3.46±0.24[b]	2.76±0.25[ab]	3.15±0.20	2.83±0.19
Feet	2.77±0.07	2.79±0.06	2.90±0.07	3.03±0.07[a]	2.77±0.07[b]	2.67±0.07[b]	2.89±0.06	2.75±0.06
Liver	1.73±0.05	1.64±0.05	1.63±0.05	1.71±0.05	1.66±0.05	1.63±0.05	1.72±0.04	1.62±0.04
Lung + trachea	0.86±0.02	0.82±0.02	0.87±0.02	0.89±0.02	0.83±0.02	0.83±0.03	0.86±0.02	0.84±0.02
Omental fat	1.86±0.19	1.99±0.19	2.06±0.19	1.11±0.19	2.14±0.19	2.66±0.21	2.11±0.16	1.83±0.16
Reproductive organs	0.20±0.01	0.17±0.01	0.14±0.01	0.17±0.01	0.17±0.01	0.17±0.01	0.16±0.01	0.18±0.01
Spleen	0.21±0.01	0.18±0.01	0.21±0.01	0.18±0.01	0.20±0.01	0.21±0.01	0.21±0.01	0.19±0.01
Heart	0.45±0.02	0.40±0.02	0.44±0.02	0.43±0.02	0.43±0.02	0.44±0.02	0.44±0.01	0.42±0.01
Diaphragm	0.36±0.02	0.38±0.02	0.34±0.02	0.38±0.02	0.32±0.02	0.39±0.02	0.35±0.01	0.37±0.02
Kidneys	0.30±0.01	0.29±0.01	0.30±0.01	0.32±0.01	0.29±0.01	0.28±0.01	0.30±0.01	0.29±0.01
Dressing percentage (%)								
x	45.1 ±0.44	45.8 ±0.44	44.9 ±0.47	43.8 ±0.43[a]	45.5 ±0.44[b]	46.5 ±0.48[b]	45.5 ±0.37	45.0 ±0.36
y	55.8 ±0.38	56.1 ±0.38	55.9 ±0.40	55.3 ±0.37	56.0 ±0.38	56.5 ±0.50	55.6 ±0.32	56.2 ±0.31

[1] AN = Anglo-Nubian.

[a,b] Means within main effects within rows with differing scripts differ significantly

x (hot carcass weight/fasted live-weight) × 100

y (hot carcass weight/empty body weight) × 100

when slaughtered at the same weight. However, Pralomkarn (1990) found in Australian cashmere goats that there was no significant difference between feeding levels for dressing percentage and dissectible carcass fractions. *Ad lib.* kids had significantly lower head plus feet (%) than did the restricted kids. In a study made in tropical area, Pralomkarn et al. (1993b) reported that there was no significant difference between three levels of feeding {Maintenance. M; 1.2 M and *ad lib.* (1.9 M)} for dissectible carcass fractions.

TABLE 3. MEAN SQUARES FROM ANALYSIS OF VARIANCE FOR DISSECTIBLE CARCASS FRACTIONS, MUSCLE TO BONE RATIOS AND MUSCLE PLUS FAT TO BONE RATIOS

Source	Genotype (G)	Feeding (F)	Parasite (P)	G × F	G × P	F × P	G × F × P	Error
Muscle (%)	2.860	40.926**	3.943	4.599	7.585	4.983	1.366	2.537
Total fat (%)	9.137	150.760**	7.711	6.126	6.762	12.958	8.259	5.204
Subcutaneous fat (%) ** **	0.028	0.755*	0.426	0.210	0.038	0.279	0.180	0.190
Intermuscular fat (%)	6.446	54.609**	9.207*	1.960	0.934	11.149*	1.815	1.902
Pelvic fat (%)	0.0004	0.246*	0.005	0.019	0.004	0.005	0.012	0.046
Kidney fat (%)	0.728	14.801*	0.701	0.529	2.202	0.210	2.211	1.549
Bone (%)	6.095	21.682**	0.167	0.529	4.179	2.451	2.011	1.912
Connective tissue (%)	0.028	2.356	0.146	2.227	1.543	0.253	0.718	1.885
Muscle: bone ratio	0.390*	0.647*	0.005	0.097	0.223	0.064	0.116	0.109
Muscle plus fat: bone ratio	0.809*	3.246**	0.024	0.134	0.626	0.321	0.327	0.216

* ($p < 0.05$), ** ($p < 0.01$).

The effects of parasitic infection on body composition

There was no significant difference of effect between drenched and undrenched groups on body composition of goats except intermuscular fat (%). This may be due to a non-significant difference in growth rate between the treatments (Pralomkarn et al., 1994). Sykes and Coop (1976 and 1977) found that the percentage of water in infected sheep was higher than normal and that the deposition of fat, protein and skeletal calcium and phosphorus was 15 to 45% lower than in worm-free control.

The effects of genotype and supplementary feeding on sensory characteristics

Table 4 shows mean squares from analysis of variance for sensory characteristics of goat meat. There was no significant difference between genotypes or feeding in sensory scores for aroma, flavour and acceptability. However, in Thai male goats, Intarapichet et al. (1994) found that genotypes had significant ($p < 0.01$) effects on sensory quality of goat meat. Meats of AN cross-bred goats were more acceptable and had less goaty flavour than those of the TN goats. Furthermore, meat of goats offered higher feeding had higher intense goaty flavour with lower acceptability. The effects of diet ingredients and levels of feeding on red meat flavour are dependent on the type of diet. In general, high-energy grain diets produce a more acceptable or a more intense flavour in

TABLE 4. MEAN WITH STANDARD ERROR (± SE) OF THE MAIN EFFECTS FOR GENOTYPE, FEEDING, AND PARASITE ON DISSECTIBLE CARCASS FRACTIONS, MUSCLE TO BONE RATIOS AND MUSCLE PLUS FAT TO BONE RATIOS

Parameter	Genotype			Feeding			Parasite	
	Thai native (TN)	75% TN × 25% AN[1]	50% TN × 50% AN	Grazing Only	Supplementation Low	Supplementation High	Drenched	Undrenched
Muscle (%)	62.55±0.46	61.59±0.46	61.90±0.48	64.12±0.45[a]	61.30±0.46[b]	60.62±0.50[b]	63.35±0.39	61.68±0.37
Total fat (%)	9.86±0.66	11.00±0.66	9.24±0.69	5.93±0.64[a]	11.43±0.66[b]	12.74±0.71[b]	9.56±0.56	10.50±0.54
Subcutaneous fat (%)	0.56±0.12	0.46±0.12	0.51±0.13	0.25±0.12[a]	0.52±0.12[ab]	0.77±0.14[b]	0.40±0.10	0.62±0.10
Intermuscular fat (%)	6.43±0.40	7.63±0.40	6.28±0.42	4.36±0.39[a]	7.56±0.40[b]	8.43±0.43[b]	6.27±0.34[a]	7.30±0.32[b]
Pelvic fat (%)	0.40±0.06	0.41±0.06	0.41±0.06	0.26±0.06[a]	0.41±0.06[b]	0.56±0.07[b]	0.42±0.05	0.40±0.05
Kidney fat (%)	2.46±0.36	2.49±0.36	2.03±0.38	1.05±0.35[a]	2.94±0.36[b]	2.99±0.39[b]	2.47±0.30	2.19±0.29
Bone (%)	14.99±0.40	14.79±0.40	16.16±0.42	16.82±0.39[a]	14.95±0.40[b]	14.17±0.43[b]	15.38±0.34	15.24±0.32
Connective tissue (%)	12.60±0.40	12.62±0.40	12.71±0.42	13.14±0.38	12.32±0.40	12.46±0.43	12.70±0.33	12.57±0.32
Muscle: bone ratio	4.20±0.09[a]	4.20±0.09[a]	3.88±0.10[b]	3.83±0.09[a]	4.15±0.09[b]	4.29±0.10[b]	4.10±0.08	4.08±0.08
Muscle plus fat: bone ratio	4.89±0.13[a]	4.98±0.13[a]	4.47±0.14[b]	4.19±0.13[a]	4.94±0.13[b]	5.21±0.14[b]	4.75±0.11	4.81±0.11

[1] AN = Anglo Nubian.

[a,b] Means within main effects within rows with differing scripts differ significantly.

TABLE 5. MEAN SQUARES FROM ANALYSIS OF VARIANCE FOR SENSORY CHARACTERISTICS OF GOAT MEAT

Source	Genotype (G)	Feeding (F)	G × F	Error
Characteristics				
Aroma				
Goaty	217.92	73.34	67.76	478.65
Grassy	123.92	282.83	328.46	748.81
Flavour				
Goaty	127.06	4.02	137.58	497.68
Grassy	151.41	20.09	131.69	605.31
Meaty	53.97	38.34	161.87	491.95
Milky	16.18	61.04	593.29**	313.74
Bitter	69.85	28.21	56.92	152.96
Sweet	6.77	293.27	81.37	534.78
Mettalic	20.52	17.64	27.12	147.73
Cardboard	15.10	73.98	63.01	129.21
Acceptability	439.52	652.49	71.06	529.26

** ($p < 0.01$).

red meat than low-energy forage or grass diets (Field et al., 1983; Melton, 1983 and 1990).

Literature Cited

Ash, A. J. and B. W. Norton. 1987. Studies with the Australian cashmere goats. 2. Effects of dietary protein concentration and feeding level on body composition of male and female weaner goats. Aust. J. Agric. Res. 38:971-982.

Field, R. A., J. C. Williams and G. J. Miller. 1983. The effect of diet on lamb flavour. Food Technol. 37 : 258-263.

Intarapichet, K., W. Pralomkarn and C. Chinajariyawong. 1994. Influence of genotypes and feeding on growth and sensory characteristics of goat meat. ASEAN Food J. (in press)

Melton, S. L. 1983. Effect of forage feeding on beef flavor. Food Technol. 37:239-248.

Melton, S. L. 1990. Effects of feeds on flavor of red meat: a review. J. Anim. Sci. 68:4421-4435.

Pralomkarn, W. 1990. A Comparative Study of the Effects of Cross-breeding of Goats on Live-weight Gain and Body Composition. Ph. D. Thesis, The Univ. of Queensland, Australia.

Pralomkarn, W., S. Khochapakdee, S. Chodumrongkul and S. Saithanoo. 1994. Effect of supplementation and parasitic infection on productivity of Thai native and cross-bred female weaner goats. I. Growth, parasite infestation and blood constituents. AJAS 7:547-555.

Pralomkarn, W., S. Saithanoo, S. Sripongpun and S. Kochapakdee. 1993a. Growth, feed utilization and carcass characteristics of Thai native and crossbred male goats fed with different diets. Thai J. Agric. Sci. 26:239-249.

Pralomkarn, W., S. Saithanoo, S. Kochapakdee and B. W. Norton. 1993b. Effect of genotype and plane of nutrition of Thai native and Anglo-Nubian × Thai native male weaner goats. Small Ruminant Res. (in press).

SAS User's Guide. 1987. SAS User's Guide: Statistic. 6 ed. Cary, North Carolina: SAS Institute Inc.

Stone, H., J. Sidel, S. Oliver, A. Woolsey and R. C. Singleton. 1974. Sensory evaluation by quantitative description analysis. Food Technol. 28:26-34.

Sykes, A. R. and R. L. Coop. 1976. Intake and utilization of food by growing lambs with parasitic damage to the small intestine caused by daily dosing with *Trichostrongylus colubriformis* larvae. J. Agric. Sci., Camb. 86:507-515.

Sykes, A. R. and R. L. Coop. 1977. Intake and utilization of food by growing sheep with abomasal damage caused by daily dosing with *Ostertagia circumcincta* larvae. J. Agric. Sci., Camb. 88:671-677.