



Research article

Genotype and slaughter age shape carcass, meat-quality and sensory profiles of Ta-Pao-Thong, Sam-Leuang and Ta-Pao-Thong-Kasetsart chickens

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Abstract

Native-type chickens are increasingly valued in Thailand for their distinct meat quality, but systematic comparisons of carcass and sensory attributes among Thai native-type genotypes across slaughter ages remain limited. This study evaluated 180 mixed-sex chickens of three Thai native-type genotypes, including Ta-Pao-Thong (TP), Sam-Leuang (SL), and their crossbred Ta-Pao-Thong-Kasetsart (TPK), raised under the same management conditions and slaughtered at 12, 14, and 16 weeks of age in a 3 × 3 factorial arrangement. Carcass traits, breast and thigh pH, meat color, cooking loss, Warner-Bratzler shear force and trained-panel sensory scores were determined. Slaughter weight increased with age in all genotypes and was generally higher in TPK than in SL, with TP showing intermediate values. Genotype had modest effects on pH and meat color, whereas cooking loss and shear force were influenced mainly by genotype and/or slaughter age. A sensory evaluation indicated that breast and thigh meat from all genotype-age combinations was acceptable to the trained panel. SL thigh meat, particularly at 14 and 16 weeks, showed favorable taste and overall acceptability scores, while TPK combined higher slaughter weight with acceptable sensory scores. These findings showed that the TP, SL, and TPK genotypes had diverse carcass and meat-quality profiles, supporting potential product differentiation within the 12-16-week slaughter window, pending further consumer and economic validation.

Keywords: Carcass characteristics, Meat quality, Native-type chicken, Sam-Leuang, Ta-Pao-Thong

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INTRODUCTION

Native-type chickens play a crucial role in rural livelihoods and local food cultures in Thailand. Compared with fast-growing commercial broilers, Thai indigenous and native-type chickens have slower growth, but they are often preferred for their firmer texture, stronger flavor, and distinctive eating quality (Wattanachant et al., 2004; Jaturasitha et al., 2008; Lengkidworraphiphat et al., 2021). These characteristics support their continued use in local markets and provide opportunities for product differentiation in systems where carcass quality, meat quality, and local genetic identity are valued alongside growth performance.

In response to this demand, several domestic breeds and improved native-type chickens have been developed or promoted in Thailand. Ta-Pao-Thong (TP) and Sam-Leuang (SL) are Thai native-type genetic resources with cultural and productive relevance, whereas Ta-Pao-Thong-Kasetsart (TPK) is a native-derived crossbred line developed to improve production performance while retaining desirable native-type characteristics. Recent genomic and population studies have also emphasized the importance of Thai local chicken genetic resources for conservation, breeding and product development (Budi et al., 2023). However, carcass and meat-quality data for TP, SL and TPK remain limited, particularly when these genotypes are compared under the same management conditions and at different slaughter ages.

Recent evidence also suggests that the value of Thai native-type chickens is not limited to conventional carcass traits. Thai native and native-derived chickens have been reported to contain taste-active and bioactive compounds, including glutamic acid, anserine, anserine/carnosine, and antioxidant-related metabolites, which may contribute to consumer satisfaction and functional-meat potential (Charoensin et al., 2021; Lengkidworraphiphat et al., 2021). Previous crossbreeding studies in Thai native chicken populations indicate that appropriate parental combinations can improve growth performance and carcass characteristics through combining ability and heterosis while retaining native-type attributes (Sungkhapreecha et al., 2022). These findings show the importance of genotype-by-slaughter-age evaluation because commercialization of native-type chickens requires both heavier carcasses and also preservation of the eating-quality traits that define their market identity.

Recent research has addressed Thai native or local chickens mainly in relation to dietary supplementation, growth performance, carcass quality, oxidative status, and immunity or health-related responses, such as fiber-source supplementation in Pradu Hang dum chickens and *Moringa oleifera* leaf extract in Mae Hong Son chickens (Kanjak et al., 2023; Marupanthorn et al., 2024). These studies provide useful evidence for improving local chicken production, but they do not directly compare TP, SL, and TPK across slaughter ages using carcass traits, physicochemical meat-quality indicators, and trained-panel sensory attributes in a single factorial framework. This study adds novelty by focusing on genotype and slaughter-age responses among specific Thai native-type chicken resources rather than on a dietary intervention.

Meat quality is a multidimensional construct rather than a single trait. Classical and contemporary frameworks emphasize that compositional traits, postmortem pH decline, color, water-holding capacity, tenderness, and sensory perception collectively determine meat quality (Xiong, 1999; Mancini and Hunt, 2005; Joo et al., 2013; Mir et al., 2017). In chickens, pH is closely associated with water-holding capacity, color, and tenderness, whereas instrumental measures such as Warner-Bratzler shear force provide objective information on texture. Sensory evaluation remains essential because consumer-relevant eating quality reflects an integrated perception of appearance, odor, tenderness, juiciness, flavor, and overall acceptability.

Among the many factors influencing chicken meat quality, genotype and slaughter age are two of the most critical and strongly interacting determinants.

Genotype can affect growth rate, muscle development, carcass partitioning, fat deposition, and muscle fiber characteristics, whereas slaughter age influences live weight, carcass maturity, connective tissue development, and postmortem muscle properties (Jaturasitha et al., 2008; Li et al., 2020; Nualhnuplong and Wattanachant, 2020). Therefore, the optimal slaughter age for one genotype may not necessarily be optimal for another, particularly for slow-growing native-type chickens.

A growing body of research has described carcass composition and meat quality of Thai indigenous and native-type chickens raised under various production systems (Wattanachant et al., 2004; Jaturasitha et al., 2008; Nualhnuplong and Wattanachant, 2020; Lengkidworraphiphat et al., 2021). However, integrated comparisons of TP, SL, and TPK across multiple slaughter ages are scarce. This information is needed to guide breeding, production, and potential product-positioning decisions for Thai native-type chickens.

Therefore, this study was conducted to compare carcass characteristics, physicochemical meat quality, and sensory attributes of TP, SL, and TPK chickens slaughtered at 12, 14, and 16 weeks of age under the same rearing conditions. This study evaluated the main effects of genotype and slaughter age on carcass traits, meat-quality indices, and sensory scores and determined whether genotype $\times$ slaughter age interactions generated distinct carcass and meat-quality profiles among the three genotypes. We hypothesized that genotype, slaughter age, and their interactions would influence carcass characteristics, meat-quality parameters, and sensory attributes, and that TPK would show carcass-oriented advantages while maintaining meat quality and sensory scores within the native-type range.

MATERIALS AND METHODS

Ethical approval

All animal procedures were conducted in accordance with the guidelines for the care and use of animals in research, and were approved by the Animal Care and Use Research Ethics Committee of Kasetsart University, Bangkok, Thailand (Approval No. ACKU 60-AGK-041).

Animals and experimental design

A total of 180 mixed-sex day-old chicks of three Thai native-type chicken genotypes as Ta-Pao-Thong (TP), Sam-Leuang (SL), and their crossbred Ta-Pao-Thong-Kasetsart (TPK) were obtained from the breeding unit of the Department of Animal Science, Kasetsart University, Kamphaeng Saen Campus, Thailand. Upon arrival, the chicks were individually wing-banded. Each genotype was housed in six floor pens, with 10 birds per pen, giving 60 birds per genotype. Each pen measured 2×3 m, corresponding to a stocking density of 1.67 birds/m².

The experiment followed a 3×3 factorial arrangement in a completely randomized design, with genotype (TP, SL, and TPK) and slaughter age (12, 14, and 16 weeks) as the main factors. Within each genotype, birds were pre-assigned to one of three slaughter ages to obtain 20 birds per genotype at each slaughter age. Birds of both sexes were used, but sex was not recorded. Therefore, sex could not be included as a fixed factor or covariate in the statistical model. This limitation should be considered when interpreting genotype- and slaughter-age-related differences in carcass and meat-quality traits.

The sample size of 20 birds per genotype-age combination was selected based on the availability of the three native-type chicken genotypes and on common practice for carcass and meat-quality comparisons in slow-growing chickens, while maintaining a balanced factorial structure for individual-bird measurements.

Housing, feeding and management

The birds were reared in an open-sided poultry house in floor pens with rice husk litter. Each pen was equipped with bell drinkers and tube feeders, and birds had ad libitum access to feed and water throughout the trial. Environmental conditions were managed using natural ventilation and supplemental heating during brooding. Temperature and relative humidity were not continuously recorded; therefore, temperature-humidity index values could not be calculated. The chicks received continuous lighting during the first week, followed by a standard light-dark cycle appropriate for slow-growing meat-type chickens.

From 0 to 4 weeks of age, birds were fed a starter diet formulated to contain 21% crude protein and 2,900 kcal/kg metabolizable energy. From 4 to 16 weeks of age, they received a grower diet containing 18% crude protein and 3,000 kcal/kg metabolizable energy. The diets were based on corn-soybean meal and formulated to meet or exceed the nutrient requirements for meat-type chickens according to the Nutrient Requirements of Poultry (NRC, 1994). The feed was provided in mash form. The birds were inspected daily for health and welfare, and any mortality or morbidity was recorded. Vaccination was performed according to the standard program recommended by the Department of Livestock Development, Thailand, with no medication administered during the trial.

Slaughter procedures and carcass trait measurements

At each slaughter age (12, 14, and 16 weeks), 20 birds per genotype were selected for slaughter and carcass evaluation. The birds were fasted for 6 h with free access to water and individually weighed to determine live body weight. They were then electrically stunned and slaughtered by exsanguination, scalded, defeathered, and eviscerated following standard poultry processing procedures. The heads, necks, shanks, and viscera were removed, and the carcasses were washed and chilled at 4°C for 24 h.

The chilled carcasses were weighed to obtain cold carcass weight, and carcass yield was expressed as dressing percentage using the following formula:

$$\text{Dressing percentage (\%)} = (\text{chilled carcass weight} / \text{live body weight}) \times 100.$$

Each carcass was then cut into major commercial portions, including breast, thigh, drumstick, wing, tenderloin, and body frame, as well as a four-portion yield. The weight of each cut was recorded and expressed as a percentage of cold carcass weight to characterize carcass composition.

Meat quality measurements

Breast (pectoralis major) and thigh (biceps femoris region) muscles from the right side of each carcass were excised for meat-quality analysis. The samples were placed on plastic trays, wrapped with oxygen-permeable film, and stored at 4°C until measurement.

Muscle pH was measured at 1, 6, and 24 h postmortem using a portable pH meter (FiveGo pH meter F2 with LE427 probe, Mettler-Toledo AG, Switzerland). The pH meter was calibrated with pH 7.00 and 4.01 buffer solutions before measurement. The electrode was inserted 2.5 cm into the muscle. The surface color of the breast and thigh muscles at 24 h postmortem was measured using a color meter (HunterLab MiniScan EZ, USA). The instrument was standardized with black glass and white tile color standards before measurement. Meat color was expressed as CIE L^* , a^* , and b^* values, following established guidelines for meat-color evaluation (AMSA, 2012; Mancini and Hunt, 2005). Implausible breast L^* values outside the valid CIE L^* scale were checked during the revision and treated as data-entry or measurement errors before re-analysis.

For cooking loss and Warner-Bratzler shear force measurements, the central portion of each breast sample was prepared to a size of 5 × 7 cm. The samples were weighed before cooking, individually vacuum-packed, and cooked in a water

bath (Techne, Temperor, England) at 85°C until the core temperature reached 82°C. The internal temperature was monitored using a thermocouple inserted into the geometric center of the sample. The cooked samples were cooled to room temperature, blotted dry, and reweighed. Cooking loss was calculated as the percentage difference between the raw and cooked weights.

For instrumental tenderness, the cooked samples were cut into rectangular strips measuring 1.0 × 1.0 cm. Each strip was sheared perpendicular to the muscle fiber direction using a Material Testing Machine (LR5K, Lloyd Instruments, UK) fitted with a V-type blade and a 500 N load cell (S2M/500N Force Transducer, Singapore). The crosshead speed was set at 60 mm/min. Each sample was tested six times, and the peak maximum force, recorded in Newtons (N), was used to determine the Warner-Bratzler shear force, following reference procedures for meat tenderness assessment (Boccard et al., 1981; AMSA, 1995).

Sensory evaluation

A sensory evaluation of the cooked breast and thigh meat was conducted using eight trained panelists. The samples were roasted in an oven (ELBA F6ET, Model 211-800X, Italy) at 175°C until the internal temperature reached 82°C. The cooked samples were rested on a rack at room temperature for 7 min and then cut into 1 × 1 cm pieces before serving.

The panelists evaluated six sensory attributes as color, odor, tenderness, juiciness, flavor, and overall acceptability. Evaluations were performed using a nine-point structured scale, where 1 indicated extremely unacceptable and 9 indicated extremely acceptable. Samples representing each genotype-age combination were coded and presented in a randomized order. The panelists evaluated the samples twice weekly, with eight samples evaluated per session. Water was provided to cleanse the palate between samples. The scores of the panelists were averaged for each sample before statistical analysis.

Statistical analysis

The carcass and meat-quality data were analyzed using a two-way analysis of variance (ANOVA) in a 3 × 3 factorial arrangement with genotype (TP, SL, and TPK) and slaughter age (12, 14, and 16 weeks) as fixed factors. The birds were housed in six floor pens per genotype, with 10 birds per pen. For carcass traits and meat-quality measurements, each bird was used as the observational unit because all measurements were obtained from individually slaughtered and evaluated birds. The pen was not included as a random effect in the statistical model; therefore, possible pen- or microenvironment-related variation could not be fully separated from genotype effects. The results should, therefore, be interpreted as individual-bird responses under the specific housing and management conditions of this study, rather than as fully pen-replicated production-system effects.

Birds of both sexes were used, but sex was not recorded. Therefore, sex could not be included as a fixed factor or covariate in the statistical model. Data were pooled within each genotype-age group, and the results should be interpreted as overall genotype- and slaughter-age-related responses under the conditions of this study. Sex-related variation could not be separated from genotype and slaughter-age effects; therefore, future studies should use sex-recorded and sex-balanced designs with sufficient sample size to evaluate sex as an explicit factor and clarify its interactions with genotype and slaughter age.

The following two-way ANOVA model was fitted to each response variable:

$$Y_{ijk} = \mu + G_i + A_j + (G \times A)_{ij} + e_{ijk}$$

where Y_{ijk} is the observation for bird k in genotype i and slaughter age j , μ is the overall mean, G_i is the fixed effect of genotype, A_j is the fixed effect of slaughter age, $(G \times A)_{ij}$ is the interaction between genotype and slaughter age, and e_{ijk} is the residual error term.

The residuals were inspected using normal probability plots and plots of residuals versus fitted values to assess normality and homogeneity of variance. When substantial deviations from these assumptions were detected, data were transformed using an appropriate transformation; otherwise, untransformed data were used. Given the number of correlated carcass and meat-quality traits, the interpretation emphasized coherent patterns and effect directions across related variables rather than isolated P values.

For variables with significant genotype $\times$ slaughter age interactions, simple-effect comparisons were examined using estimated marginal means. Genotype differences within each slaughter age and slaughter-age differences within each genotype were used to support interaction interpretation and are reported concisely in the Results section where relevant. For variables with significant main effects but no significant interaction, marginal mean patterns were interpreted. For sensory traits, panelist scores were averaged for each sample before analysis; panelist and session were not included as random effects, and sensory findings should, therefore, be interpreted as trained-panel responses rather than representative consumer-preference data. Sensory scores were treated as continuous variables for analysis, acknowledging that they originated from an ordinal scale. Statistical significance was declared at $P < 0.05$. All statistical analyses were performed using SPSS Statistics 17.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Carcass characteristics and cut yields

Slaughter weight was significantly affected by genotype, slaughter age, and genotype $\times$ slaughter age interaction ($P < 0.05$; Table 1). Across genotypes, live body weight increased from 12 to 16 weeks, with mean values ranging from 1.53 kg in SL at 12 weeks to 2.11 kg in TPK at 16 weeks. Simple-effect comparisons showed that TP was heavier than SL at 12 weeks ($P = 0.003$), TPK was heavier than both SL and TP at 14 weeks ($P = 0.002$ and $P = 0.001$, respectively), and TPK was heavier than SL at 16 weeks ($P = 0.016$). Within genotype, slaughter weight increased with age: in TPK and SL, 14- and 16-week birds were heavier than 12-week birds ($P < 0.001$), whereas in TP, 16-week birds were heavier than 12- and 14-week birds ($P = 0.004$ and $P = 0.002$, respectively).

Table 1 Carcass cuts and cut-up yields of Ta-Pao-Thong (TP), Sam-Leuang (SL), and Ta-Pao-Thong-Kasetsart (TPK) chickens at different slaughter ages.

Genotype	Age (weeks)	Slaughter weight (g)	Dressing (%)	Retail cuts (%)						
				Breast	Thigh	Drumstick with bone	Wing	Tenderloin	Body frame	Four- portion
TP	12	1776.43 ^{cd}	85.92	10.13	14.48 ^{cd}	11.81 ^{bc}	10.31	3.14	20.94	39.56
	14	1760.22 ^{cd}	85.24	10.29	14.55 ^{cd}	11.63 ^{bc}	10.09	3.04	21.14	39.51
	16	2049.00 ^{ab}	89.21	10.53	15.77 ^a	12.32 ^{ab}	9.58	3.58	21.58	42.21
SL	12	1533.96 ^e	86.80	11.32	14.65 ^{bcd}	11.13 ^c	9.69	3.20	21.75	40.29
	14	1796.59 ^{cd}	84.44	10.99	14.10 ^d	11.33 ^c	9.68	3.12	21.54	39.54
	16	1902.86 ^{bc}	86.33	10.82	14.93 ^{bc}	11.79 ^{bc}	9.78	3.22	20.93	40.76
TPK	12	1650.00 ^{de}	88.31	11.47	14.78 ^{bcd}	12.02 ^{abc}	10.31	3.15	21.20	41.42
	14	2024.35 ^{ab}	88.18	10.41	15.21 ^{abc}	12.83 ^a	10.09	3.10	21.32	41.54
	16	2112.63 ^a	87.42	10.84	15.30 ^{ab}	11.76 ^{bc}	9.58	3.18	21.67	41.08
SEM		19.502	0.399	0.106	0.078	0.101	0.066	0.030	0.184	0.212
P value										
Genotype		0.001	0.081	0.016	0.012	0.004	0.217	0.332	0.905	0.059
Age		0.001	0.209	0.249	0.001	0.394	0.295	0.005	0.978	0.079
Genotype × age		0.016	0.286	0.270	0.041	0.049	0.259	0.074	0.715	0.131

SEM = standard error of the mean. Four-portion = breast + tenderloin + thigh + drumstick with bone. TP = Ta-Pao-Thong; SL = Sam-Leuang; TPK = Ta-Pao-Thong-Kasetsart. a-e Means within a column with different superscript letters differ significantly ($P < 0.05$).

Dressing percentage ranged from 84 to 89% and did not differ markedly among genotypes or ages (Table 1), although genotype had a marginal effect ($P = 0.081$). Therefore, the heavier slaughter weights observed in TPK should be interpreted mainly as differences in body size rather than as clear evidence of higher dressing percentage.

The proportions of carcass cuts showed some significant genotype, age, and genotype × age effects (Table 1). Breast yield accounted for 10.1 to 11.5% of carcass weight and was affected by genotype ($P = 0.016$). Thigh yield (14.1–15.8%) was affected by genotype, age, and their interaction; genotype differences were most evident at 14 weeks, when TPK had higher thigh yield than SL ($P < 0.001$) and TP ($P = 0.044$). Drumstick yield (11.1–12.8%) also showed genotype and genotype × age effects, with TPK showing higher values than SL and TP at 14 weeks ($P < 0.001$ and $P = 0.005$, respectively). Wing, tenderloin, body frame, and four-portion yield showed only minor differences among genotype-age combinations, and most values varied within a relatively narrow range in the present dataset (Table 1).

pH of breast and thigh muscles

Breast muscle pH values at 1, 6, and 24 h postmortem were within a relatively narrow range of 5.54 to 5.72 across all treatments (Table 2). Genotype had a significant effect on breast pH at 6 h ($P = 0.004$), and genotype × age interactions were significant for breast pH at 1, 6, and 24 h postmortem ($P \leq 0.003$). Simple-effect comparisons indicated that genotype differences were age-specific rather than consistent across all slaughter ages. At 12 weeks, TPK had higher breast pH at 1 h than SL ($P = 0.012$), and TPK and TP had higher breast pH at 6 h than SL ($P = 0.001$ and $P = 0.042$, respectively). At 16 weeks, TPK had higher breast pH at 1 h than TP ($P = 0.004$), and higher breast pH at 6 and 24 h than SL ($P = 0.019$ and $P = 0.007$, respectively) and TP ($P < 0.001$ and $P = 0.003$, respectively).

Table 2 pH values of breast and thigh meat from Ta-Pao-Thong (TP), Sam-Leuang (SL), and Ta-Pao-Thong-Kasetsart (TPK) chickens at different slaughter ages.

Genotype	Age (weeks)	Breast pH			Thigh pH		
		1 h	6 h	24 h	1 h	6 h	24 h
TP	12	5.65 ^{abc}	5.62 ^{abc}	5.69 ^{abc}	6.04 ^{cd}	6.04	6.10 ^a
	14	5.68 ^{ab}	5.60 ^{bcd}	5.70 ^{ab}	6.19 ^a	6.06	6.10 ^a
	16	5.62 ^{bc}	5.54 ^c	5.64 ^{cd}	5.98 ^c	5.84	5.93 ^b
SL	12	5.59 ^c	5.56 ^c	5.66 ^{bcd}	6.03 ^{cd}	5.93	6.05 ^a
	14	5.71 ^a	5.57 ^{bcd}	5.69 ^{abc}	6.15 ^{ab}	5.99	6.12 ^a
	16	5.69 ^{ab}	5.56 ^c	5.64 ^c	6.02 ^{cd}	5.80	5.92 ^b
TPK	12	5.70 ^{ab}	5.67 ^a	5.72 ^a	6.05 ^{cd}	5.88	5.92 ^b
	14	5.64 ^{abc}	5.56 ^{cd}	5.66 ^{bcd}	6.08 ^{bc}	5.94	6.06 ^a
	16	5.72 ^a	5.63 ^{ab}	5.70 ^{ab}	6.04 ^{cd}	5.86	5.93 ^b
SEM		0.009	0.007	0.006	0.010	0.012	0.010
P value							
Genotype		0.221	0.004	0.069	0.862	0.004	0.002
Age		0.354	0.051	0.067	0.001	0.001	0.001
Genotype × age		0.003	0.001	0.002	0.010	0.061	0.024

SEM = standard error of the mean. TP = Ta-Pao-Thong; SL = Sam-Leuang; TPK = Ta-Pao-Thong-Kasetsart. a-d Means within a column with different superscript letters differ significantly among genotype × age combinations ($P < 0.05$).

Thigh muscle pH values were generally higher than those of breast, with means ranging from about 5.80 to 6.19 (Table 2). Age had significant effects on thigh pH at all measurement times ($P \leq 0.001$), whereas genotype affected thigh pH at 6 and 24 h postmortem ($P \leq 0.004$). Significant genotype × age interactions were detected for thigh pH at 1 and 24 h postmortem ($P = 0.010$ and $P = 0.024$, respectively). For thigh pH at 1 h, genotype differences occurred only at 14 weeks, when TP showed higher thigh pH than TPK ($P = 0.001$). For thigh pH at 24 h, genotype differences were detected only at 12 weeks, where SL and TP had higher pH values than TPK ($P = 0.009$ and $P < 0.001$, respectively). Within genotype, TPK showed higher thigh pH at 24 h at 14 weeks than at 12 and 16 weeks ($P = 0.001$ and $P < 0.001$, respectively), whereas SL and TP showed lower values at 16 weeks than at earlier slaughter ages.

Meat color, shear force and cooking loss

Instrumental color values for breast and thigh muscles are presented in Table 3. Breast lightness (L^*) ranged from about 59 to 65 and was significantly affected by genotype and genotype × age interaction ($P = 0.002$ and $P = 0.022$, respectively). Simple-effect comparisons indicated that genotype differences were evident only at 12 weeks, when TP showed higher Breast L^* than TPK and SL ($P = 0.001$ and $P < 0.001$, respectively). Within genotype, age-related differences were evident only in TP, where Breast L^* was higher at 12 weeks than at 14 and 16 weeks ($P = 0.025$ and $P = 0.008$, respectively). Breast a^* was affected by age ($P = 0.020$), whereas breast b^* did not show significant effects (Table 3).

Table 3 Meat color, Warner-Bratzler shear force and cooking loss of breast and thigh meat from Ta-Pao-Thong (TP), Sam-Leuang (SL), and Ta-Pao-Thong-Kasetsart (TPK) chickens at different slaughter ages.

Genotype	Age (week)	Breast			Thigh			Shear force (N)	Cooking loss (%)
		L^*	a^*	b^*	L^*	a^*	b^*		
TP	12	64.96 ^a	7.79	19.11	55.49	8.95	14.54	24.59	21.28
	14	62.19 ^{bc}	6.86	18.47	54.14	8.58	15.18	23.31	21.07
	16	61.54 ^{bc}	6.61	17.50	52.92	8.73	13.40	28.20	19.35
SL	12	59.26 ^c	7.96	17.98	54.92	8.28	15.38	28.37	18.33
	14	62.33 ^{bc}	7.19	18.45	55.96	7.87	14.10	25.68	17.25
	16	61.26 ^{bc}	6.93	17.62	56.72	6.94	14.24	30.65	15.77
TPK	12	60.14 ^{bc}	7.41	18.41	53.28	8.22	14.48	25.78	16.59
	14	60.81 ^{bc}	7.53	18.02	55.86	7.88	14.60	25.93	18.57
	16	60.67 ^{bc}	7.28	18.16	54.33	7.73	14.40	28.82	17.70
SEM		0.305	0.109	0.132	0.346	0.135	0.227	0.607	0.215
P value									
Genotype		0.002	0.377	0.591	0.151	0.003	0.940	0.180	0.001
Age		0.675	0.020	0.059	0.600	0.138	0.329	0.008	0.019
Genotype*Age		0.022	0.426	0.200	0.174	0.678	0.424	0.925	0.053

SEM = standard error of the mean. L^* = lightness; a^* = redness; b^* = yellowness; TP = Ta-Pao-Thong; SL = Sam-Leuang; TPK = Ta-Pao-Thong-Kasetsart. P values for Breast L^* were revised after data checking and exclusion of implausible values outside the valid CIE L^* scale.

Thigh muscle L^* and b^* values did not differ significantly among genotypes or ages. By contrast, thigh a^* was significantly affected by genotype ($P = 0.003$), with TP generally showing higher redness values than SL and TPK. However, the magnitude of these color differences was small, and all treatments remained within a typical range for native-type chicken meat (Table 3).

Shear force values increased with slaughter age ($P = 0.008$), while genotype and genotype $\times$ age interaction were not significant (Table 3). Across all treatments, shear force ranged from 23 to 31 N, with lower values generally observed at 12 and 14 weeks and higher values at 16 weeks. Cooking loss was significantly affected by genotype and slaughter age ($P \leq 0.019$), whereas the genotype $\times$ age interaction was marginal but not significant ($P = 0.053$). Across slaughter ages, TP generally showed higher cooking loss than TPK and SL, while SL showed the lowest cooking loss at 16 weeks.

Sensory evaluation of breast meat

Sensory scores for cooked breast meat are summarized in Table 4. For all traits, mean scores ranged from 7.0 to 8.5 on the nine-point scale, indicating favorable trained-panel responses. Neither genotype nor age had a significant main effect on overall acceptability ($P \geq 0.383$), although a significant genotype $\times$ age interaction was detected ($P = 0.004$).

Table 4 Sensory evaluation of breast meat from Ta-Pao-Thong (TP), Sam-Leuang (SL), and Ta-Pao-Thong-Kasetsart (TPK) chickens at different slaughter ages.

Trait	Genotype	Age			SEM	P value		
		12	14	16		Genotype	Age	Genotype*Age
Color	TP	7.80	8.13	7.50	0.123	0.109	0.807	0.006
	SL	7.93	7.73	7.80	0.091			
	TPK	7.80	7.93	8.50	0.098			
Flavor	TP	7.60	7.60	7.30	0.109	0.454	0.609	0.478
	SL	7.60	7.60	7.53	0.078			
	TPK	7.53	7.27	7.50	0.084			
Tenderness	TP	7.80	7.73	7.70	0.132	0.229	0.316	0.147
	SL	7.40	7.73	7.40	0.097			
	TPK	7.33	7.73	8.10	0.105			
Juiciness	TP	7.80	7.40	7.33	0.121	0.022	0.592	0.296
	SL	7.46	7.40	7.13	0.089			
	TPK	7.00	7.07	7.20	0.097			
Taste	TP	8.00	7.53	7.40	0.150	0.109	0.052	0.068
	SL	8.27	7.93	7.33	0.111			
	TPK	7.33	7.67	7.50	0.120			
Overall acceptability	TP	8.00	7.73	7.50	0.119	0.624	0.383	0.004
	SL	7.93	7.87	7.33	0.088			
	TPK	7.27	7.67	7.90	0.095			

SEM = standard error of the mean. Sensory scores were evaluated using a nine-point structured scale, where 1 = extremely unacceptable and 9 = extremely acceptable. TP = Ta-Pao-Thong; SL = Sam-Leuang; TPK = Ta-Pao-Thong-Kasetsart.

Breast color scores showed a significant genotype $\times$ age interaction ($P = 0.006$). Simple-effect comparisons indicated that genotype differences were mainly evident at 16 weeks, when TPK received higher breast color scores than SL and TP ($P = 0.006$ and $P < 0.001$, respectively). For breast overall acceptability, genotype differences were evident at 12 weeks, where SL and TP scored higher than TPK ($P = 0.002$ and $P = 0.017$, respectively); however, no genotype differences were detected at 14 weeks, and differences at 16 weeks were only marginal. Flavor, tenderness, juiciness, and taste did not show consistent genotype- or age-related patterns large enough to indicate a clear sensory superiority of any single genotype-age combination for breast meat.

Sensory evaluation of thigh meat

Sensory scores for cooked thigh meat are presented in Table 5. As with breast meat, most traits scored between 7.0 and 8.9, indicating that all genotype-age combinations were acceptable to the trained panel. Significant genotype $\times$ age interactions were observed for thigh color, taste, and overall acceptability ($P \leq 0.034$).

Table 5 Sensory evaluation of thigh meat from Ta-Pao-Thong (TP), Sam-Leuang (SL), and Ta-Pao-Thong-Kasetsart (TPK) chickens at different slaughter ages.

Trait	Genotype	Age			SEM	P value		
		12	14	16		Genotype	Age	Genotype*Age
Color	TP	7.20	7.40	7.80	0.131	0.001	0.117	0.009
	SL	8.27	8.07	8.60	0.097			
	TPK	8.20	8.93	8.30	0.105			
Flavor	TP	7.60	7.60	7.60	0.116	0.563	0.103	0.291
	SL	7.33	8.00	7.87	0.086			
	TPK	7.47	7.60	7.80	0.093			
Tenderness	TP	8.00	7.87	7.80	0.142	0.054	0.510	0.254
	SL	7.20	7.87	7.80	0.105			
	TPK	7.93	7.93	8.10	0.113			
Juiciness	TP	8.00	7.47	7.30	0.145	0.685	0.795	0.062
	SL	7.07	7.67	7.67	0.107			
	TPK	7.60	7.67	7.50	0.116			
Taste	TP	8.20	7.40	6.90	0.150	0.012	0.323	0.019
	SL	7.87	8.07	8.27	0.111			
	TPK	7.87	7.93	7.90	0.120			
Overall acceptability	TP	8.00	7.67	7.50	0.118	0.116	0.142	0.034
	SL	7.60	8.40	8.07	0.087			
	TPK	7.80	8.00	7.80	0.094			

SEM = standard error of the mean. Sensory scores were evaluated using a nine-point structured scale, where 1 = extremely unacceptable and 9 = extremely acceptable. TP = Ta-Pao-Thong; SL = Sam-Leuang; TPK = Ta-Pao-Thong-Kasetsart.

For thigh color, genotype differences were detected at all slaughter ages. At 12 weeks, TPK and SL scored higher than TP ($P = 0.004$ and $P = 0.002$, respectively). At 14 weeks, TPK scored higher than both SL and TP (both $P < 0.001$), and SL scored higher than TP ($P = 0.006$). At 16 weeks, SL scored higher than TP ($P = 0.003$). Thigh taste scores showed genotype differences at 14 and 16 weeks. At 14 weeks, SL scored higher than TP ($P = 0.016$); at 16 weeks, both TPK and SL scored higher than TP ($P = 0.003$ and $P < 0.001$, respectively). High overall acceptability also showed an interaction, with SL scoring higher than TP at 14 weeks ($P = 0.001$), whereas genotype differences at 16 weeks were only marginal. Across both breast and thigh meat, no genotype-age combination fell below the acceptable range of the scale, supporting the view that TP, SL, and TPK all provided favorable eating quality under the conditions of this study.

DISCUSSION

This study evaluated how genotype and slaughter age jointly influenced carcass traits, physicochemical meat quality, and sensory attributes in three Thai native-type chicken genotypes. The main finding was that TPK showed a carcass-oriented advantage, particularly in slaughter weight, whereas TP and SL retained distinct native-type characteristics in meat-quality and sensory traits. Importantly, the differences among genotypes and ages were not uniform across all variables, indicating that genotype-age combinations should be interpreted as quality profiles rather than as a simple ranking from best to worst.

As expected for slow-growing native-type chickens, live body weight and carcass output increased with slaughter age in all three genotypes. This increase reflected normal growth and tissue deposition between 12 and 16 weeks. TPK generally produced heavier birds than SL and often approached or exceeded TP, especially at 14 and 16 weeks, suggesting that the crossbred line may provide improved carcass size under the production conditions used in this study. This pattern concurred with the general role of crossbreeding in improving growth and

carcass traits through combining ability and heterosis in Thai native chicken populations (Sungkhapreecha et al., 2022).

Dressing percentage did not show a strong or consistent response to genotype or age, indicating that heavier body weight did not necessarily translate into a proportionally higher dressed carcass yield. This distinction is important because producers may benefit from heavier carcasses in absolute terms, whereas dressing percentage reflects carcass efficiency relative to live weight. The relatively narrow differences in cut yields further suggested that the three genotypes retained broadly comparable carcass partitioning, although thigh and drumstick yields showed some genotype-age specific patterns.

The pH values observed in breast and thigh muscles were within ranges generally reported for chicken meat, suggesting that no marked abnormal pH condition was evident. Several statistically significant pH effects and interactions were detected, but the absolute differences among treatment means were small. Therefore, their practical relevance should be interpreted cautiously. The higher pH values of thigh compared with breast are biologically plausible because thigh muscle contains a higher proportion of oxidative fibers and differs in postmortem metabolism compared with breast muscle (Joo et al., 2013; Mir et al., 2017).

Instrumental color differences were also modest. Meat color is influenced by pH, myoglobin content, muscle-fiber type, and postmortem oxidation state (Mancini and Hunt, 2005). The genotype effect on thigh redness may reflect differences in muscle composition or pigment concentration among native-type genotypes. However, the magnitude of the differences was limited, and most color values remained within a narrow range; therefore, these findings should be interpreted as subtle physicochemical variations rather than as major product-quality divergence.

Water-holding capacity, expressed as cooking loss, was affected by genotype and slaughter age, but the interaction was only marginal. In TP and SL, cooking loss declined with advancing age, whereas TPK showed less consistent changes. Age-related differences in water-holding capacity may reflect variation in pH, muscle structure, and connective tissue development (Mir et al., 2017; Li et al., 2020). In this study, cooking loss remained within a relatively moderate range, suggesting that water-holding capacity was generally stable within the 12-16-week slaughter window.

Instrumental shear force generally increased with slaughter age, particularly between 12 and 16 weeks, suggesting a gradual decline in tenderness at older ages. This pattern concurred with previous observations in native or local meat-type chickens, where greater muscle-fiber diameter and more developed connective tissue at later ages were associated with tougher meat (Li et al., 2020; Nualhnuplong and Wattanachant, 2020). Shear force values for all genotype-age combinations remained within ranges generally reported for chicken meat, and changes in instrumental tenderness were not always mirrored by large changes in sensory tenderness scores. This imperfect correspondence between instrumental and sensory tenderness is commonly observed when treatment differences are moderate rather than extreme (Mir et al., 2017).

Sensory evaluation by a trained panel showed that cooked breast and thigh meat from all genotype-age combinations were rated in the acceptable-to-liked range for color, odor, tenderness, juiciness, flavor, and overall acceptability. These results supported the interpretation that all three native-type genotypes produced meat with favorable eating quality under the conditions of this study. However, because the panel was trained and relatively small, the sensory results should be interpreted as analytical sensory evidence rather than as direct evidence of broad consumer preference.

Some genotype-specific sensory patterns may nevertheless have practical implications. SL thigh meat received favorable taste and overall acceptability scores at older slaughter ages, despite producing lighter carcasses than TPK. This suggested a potential role for SL in leg-meat-oriented or flavor-oriented product

segments. Conversely, TPK combined higher slaughter weight with acceptable sensory scores, suggesting potential value for producers seeking more standardized native-type carcasses or cut-up products. These interpretations should be regarded as potential implications, not direct market conclusions, because consumer preference, willingness to pay, and economic performance were not directly tested in this experiment.

Recent consumer-oriented evidence supports the relevance of genotype-specific product positioning, but also reinforces the need for further validation. Willingness to pay for local organic chicken was reported to differ across consumer segments in a Thai case study on Taphao Thong-Kasetsart chicken, with taste-related values and health concerns acting as important motivators for purchase decisions (Thuannadee and Noosuwan, 2025). Therefore, the carcass and sensory findings may inform future consumer-oriented studies of TPK and other native-type chickens, but they should not be interpreted as definitive evidence of consumer behavior.

This study had several limitations that should be considered when interpreting the results. First, the experiment was conducted in a single facility under one set of feeding and management conditions. Husbandry practices were standardized across treatments, but genotype effects possibly still interacted with environmental factors specific to this setting, and the generalizability of the findings to other production systems should be approached with caution. The birds were housed within genotype groups and replicated pens were not included as experimental units. Therefore, possible genotype-associated pen or microenvironment effects could not be fully separated from genotype effects. Multi-farm or multi-region studies with replicated pens would help to confirm whether the patterns observed here hold under different climatic, nutritional, and management conditions.

Second, birds of both sexes were used, but sex was not recorded. Therefore, sex distribution across genotype-age combinations could not be verified, and sex effects or sex $\times$ genotype $\times$ age interactions could not be evaluated. This is relevant because sex may influence slaughter weight, carcass composition, muscle development, and meat-quality traits. Future studies should use sex-recorded and sex-balanced designs and include sex as an explicit factor.

Third, a substantial number of correlated carcass and meat-quality variables were analyzed using ANOVA. Residuals were examined visually and did not show major deviations from normality or homogeneity of variance; however, the reliance on visual diagnostics and the absence of formal adjustments for multiple comparisons warrant caution when interpreting P values. This study's interpretation focused on consistent patterns across related traits rather than on isolated statistical significances. Finally, the sensory evaluation was conducted using a trained panel and is best regarded as providing analytical insight into treatment differences rather than fully representative consumer data. Larger-scale consumer studies, preference mapping and willingness-to-pay analyses would be valuable to translate the quality profiles of TP, SL, and TPK into concrete marketing strategies.

CONCLUSIONS

The results indicated that genotype and slaughter age shaped the carcass and meat-quality profiles of TP, SL, and TPK chickens in different ways. TPK showed a carcass-oriented advantage through higher slaughter weight, particularly at 14 and 16 weeks, while maintaining acceptable trained-panel sensory scores. SL produced lighter carcasses but showed favorable thigh taste and overall acceptability at older ages, suggesting potential value for flavor-oriented products. TP showed intermediate carcass and sensory characteristics across the slaughter window. This study was conducted in a single facility, without replicated pens and without sex records. Therefore, the findings should be interpreted within the

management conditions of this experiment. Further pen-replicated, sex-recorded, and consumer-oriented studies are required before definitive production or market recommendations can be made.

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CONFLICT OF INTEREST

The authors declare no financial or personal conflicts of interest related to this study. Artificial Intelligence (AI)-assisted tools, including ChatGPT and QuillBot, were used only to support English language editing, manuscript structuring and clarity improvement. All scientific content, data interpretation, references and final wording were critically reviewed, verified and approved by the authors, who take full responsibility for the integrity and accuracy of the manuscript.

AUTHOR CONTRIBUTIONS

Prayad Thirawong: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Writing - original draft, Writing - review and editing.

Sukanya Yung-rahang: Methodology, Resources, Investigation.

Kunlayaphat Wuthijaree: Data curation, Writing - review and editing.

Wirawan Nuchchanart: Writing - review and editing.

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Saowaluck Yammuen-Art: Supervision, Writing - review and editing.

All authors have read and approved the final version of the manuscript.

REFERENCES

- AMSA, 1995. Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of fresh meat. American Meat Science Association, Chicago, IL, USA.
- AMSA, 2012. Meat color measurement guidelines. American Meat Science Association, Champaign, IL, USA.
- AMSA, 2016. Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of meat, 2nd edition. American Meat Science Association, Champaign, IL, USA.
- Boccard, R., Buchter, L., Casteels, E., Cosentino, E., Dransfield, E., Hood, D.E., Joseph, R.L., MacDougall, D.B., Rhodes, D.N., Schön, I., Tinbergen, B.J., Touraille, C., 1981. Procedures for measuring meat quality characteristics in beef production experiments. *Livest. Prod. Sci.* 8, 385-397.
- Budi, T., Singchat, W., Tanglertpaibul, N., Muangmai, N., Srikulnath, K., 2023. Thai local chicken breeds, Chee Fah and Fah Luang, originated from Chinese black-boned chicken and red junglefowl based on mitochondrial genome data. *Diversity*. 15, 828-836.
- Charoensin, S., Laopaiboon, B., Boonkum, W., Phetcharaburanin, J., Villareal, M.O., Isoda, H., Duangjinda, M., 2021. Thai native chicken as a potential

- functional meat source rich in anserine, anserine/carnosine, and antioxidant substances. *Animals*. 11, 902.
- Jaturasitha, S., Srikanthai, T., Kreuzer, M., Wicke, M., 2008. Differences in carcass and meat characteristics between chicken indigenous to northern Thailand (Black-boned and Thai native) and imported extensive breeds (Bresse and Rhode Island Red). *Poult. Sci.* 87, 160-169.
- Joo, S.T., Kim, G.D., Hwang, Y.H., Ryu, Y.C., 2013. Control of fresh meat quality through manipulation of muscle fiber characteristics. *Meat Sci.* 95, 828-836.
- Kanjak, P., Tapingkae, W., Lumsangkul, C., Moonmanee, T., Chaiphun, W., Chotinun, S., Yachai, M., Punyatong, M., 2023. Effect of fiber source diet supplement on growth performance, carcass quality, oxidative stress and intestinal morphology in Thai native chicken (Pradu Hang dum). *Vet. Integr. Sci.* 21, 365-381.
- Lengkidworraphiphat, P., Wongpoomchai, R., Bunmee, T., Chariyakornkul, A., Chaiwang, N., Jaturasitha, S., 2021. Taste-active and nutritional components of Thai native chicken meat: A perspective of consumer satisfaction. *Food Sci. Anim. Resour.* 41, 237-246.
- Li, J., Yang, C., Peng, H., Yin, H., Wang, Y., Hu, Y., Yu, J., Li, L., Wang, S., Tian, Y., 2020. Effects of slaughter age on muscle characteristics and meat quality traits of Da-Heng meat-type birds. *Animals*. 10, 69.
- Mancini, R.A., Hunt, M.C., 2005. Current research in meat color. *Meat Sci.* 71, 100-121.
- Marupanthorn, K., Krutthai, N., Wattanakul, W., Ketpanyapong, W., Setthaya, P., Chaiwang, N., 2024. Effects of *Moringa oleifera* leaf extract on growth performance, blood hematology, immunity, carcass, and meat quality of Mae Hong Son chicken. *Vet. Integr. Sci.* 22, 335-348.
- Mir, N.A., Rafiq, A., Kumar, F., Singh, V., Shukla, V., 2017. Determinants of broiler chicken meat quality and factors affecting them: A review. *J. Food Sci. Technol.* 54, 2997-3009.
- NRC, 1994. Nutrient requirements of poultry, 9th revised edition. National Academy Press, Washington, DC, USA.
- Nualhnuplong, P., Wattanachant, C., 2020. Effects of age at slaughter and sex on carcass characteristics and meat quality of Betong chicken. *Pertanika J. Trop. Agric. Sci.* 43, 343-357.
- Sosnówka-Czajka, E., Skomorucha, I., Muchacka, R., 2017. Effect of different production systems on carcass characteristics and meat quality of broiler chickens from various genetic groups. *Ann. Anim. Sci.* 17, 1197-1213.
- Sungkhapreecha, P., Chankitisakul, V., Duangjinda, M., Boonkum, W., 2022. Combining abilities, heterosis, growth performance, and carcass characteristics in a diallel cross from black-bone chickens and Thai native chickens. *Animals*. 12, 1602.
- Thuannadee, A., Noosuwan, C., 2025. Consumer meat preference and willingness to pay for local organic meat in Thailand: a case study of Taphao Thong-Kasetsart chicken. *J. Agribus. Dev. Emerg. Econ.* 15, 81-95.
- Wattanachant, S., Benjakul, S., Ledward, D.A., 2004. Composition, color and texture of Thai indigenous and broiler chicken muscles. *Poult. Sci.* 83, 123-128.
- Xiong, Y.L., 1999. Quality attributes of muscle foods. In: Xiong, Y.L., Ho, C.T., Shahidi, F. (Eds.), *Quality attributes of muscle foods*. Springer, Boston, MA, USA, pp. 1-16.

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