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Carcass composition and meat quality of Thai indigenous chicken raised in organic production system

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Abstract The results showed that there were no effects of breed (Pradu-hangdum; PD and Luang-hangkhao; LK), sex and its interaction on the carcass yield, wing, and edible internal organ percentage. The thigh percentage, cooking loss and a* value of breast and thigh of PD chicken was significantly lower than that of the LK chicken but higher in L* value of breast and thigh meat ($p<0.05$). The male chickens had a significantly lower breast percentage, but a higher drumstick percentage compared to the females. In addition, there was no significant effect of breed and sex on color, odor, tenderness, and flavor of breast or thigh meat. The lowest and highest overall acceptability were found on the thigh meat of LK females and PD males, respectively.

Keywords: Thai Native chicken, Organic livestock, Carcass characteristic, Sensory evaluation

Introduction

Organic poultry production system becomes increasingly growth in Thailand in recent years because of the increased demand of consumer who are concerned in natural, chemical residuals free and no negative effect in products, and who are interested in friendly environment and animal welfare. Organic poultry farming is a high standard production system which has quite strict rules in stock density, feeding, outdoor access, animal welfare, and health care protection (Molee *et al*., 2022). Meat type chicken reared in organic production system have a high value of protein, total collagen, omega-3 and omega-6 fatty acid but low of cholesterol contents in meat (Zaid *et al*., 2020). Both of production standard and nutritional value is the patronage motive of customers to pay a higher price for products from organic system.

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Several studies have specified the genetic and non-genetic factors on organic chicken performance, carcass composition, and meat quality. The finding of Fanatico *et al*. (2005) indicated that the carcass and meat quality were affected by genetic, age, sex, diet, stock density, environment, behaviour, and pasture intake. Molee *et al*. (2022) recommended that the slow-growing chicken or local breed is proper for raising in organic system because of their adaptation to feeding and environment, in addition to showing the rearing conditions tolerance and viability. Fanatico *et al.* (2005) reported that the higher breast and leg percentage, enhanced sensory quality, and lower abdominal fat in free-range chickens compared to those raised indoors. Inci *et al*. (2016) and Sosnówka-Czajka *et al.* (2017) reported the chicken meat from organic system has a low-fat content, more savoury and tastier than that raised in conventional system. Therefore, the selected Thai indigenous chicken such as Pradu-hangdum and Lueng-hangkhao for organic slow-growing chicken production could identified their potential for regional quality products. The present study is aimed to determine the effect of Thai indigenous chicken breed and sex on carcass percentage, meat quality and sensory attribute.

Material and method

Study area

The trial was conducted at the Poultry Research Farm of Maejo University, Phrae Campus, from October to December 2017. The farm was adapted for raising chickens in the organic system.

Experimental design, procedure, and ethics statement

The experiment design was completely randomized design (CRD) with 2 ×2 factorial arrangement of three replications. The first factor was Thai indigenous chicken breeds: Pradu-hangdum (PD) and Luang-hangkhao (LK), and the second factor was sex: male and female.

A total of 240 1-DOC of the native Thai breeds, 120 each of PD and LK, were assigned to three sub-groups (40 birds per replication) and raised in temperature-controlled poultry house (10 birds/ 1 m^2) from 25 to 32 ^{O}C until 21 days of age. Chicks were vaccinated against Newcastle, infectious bronchitis, and fowl pox disease. At 22 days of age, the birds were able to access the range covered with grass (4 m^2/bird) and raised until 20 weeks of age.

All birds were fed on ad libitum with the same starter (1-21 d) and grower-finisher (22 d to slaughter) diets (Table 1), which consisted of 94.70

and 92.79 percent dry matter from organic ingredients, respectively. All organic diets were made from organic chicken feed factory of Hilltribe organic, Ltd.; operation code: 56858, Chiang rai, Thailand which use certified feed ingredients authorized for organic livestock production, in accordance with Organic Agriculture Certification Thailand (ACT) Standard of 7 July 2017. Fresh and clean drinking water was provided to the birds for the whole duration of the study. All experimental procedures were conducted following the Maejo University Animal Care and Use committee, approval number: MACUC 008A/2559.

Table 1. Ingredient composition and calculated analysis of organic diets

Item	Diet I (0-4 wk)	Diet II (5 wk to end of rearing)
Ingredient		
Corn1	63.27	67.55
Rice bran1	3.00	5.20
Soybean1	26.45	19.60
Fish meal	4.50	5.00
Limestone	1.20	1.30
Dicalcium phosphate	1.18	0.95
Salt	0.40	0.40
Chemical composition		
CP (%)	20.03	18.01
ME (Kcal/kg)	2,915	2,960
Ether extract (%)	2.71	3.02
Fiber (%)	2.95	2.89
Calcium (%)	0.99	1.00
Available Phosphorus (%)	0.50	0.50

[1/] organic feedstuff

Carcass composition

At 20 wk of age, a total of 12 birds (6 female and 6 male) per strain were randomly obtained to determine the dressing percentage and cut up yield. Each bird was weighed live and slaughtered after 8 hours of feed withdrawal. All birds were electrically stunned and bled from the unilateral section of the jugular vein and placed the carcass in hot water (57 ^{O}C), defeathered, and eviscerated. The commercial cuts (breast, tights, drumsticks, and wings) and edible giblets (heart, liver, and gizzard) were weighed and determined their

yield as a percentage of body weight. The breast and thigh samples were collected and stored at 4 ^{O}C for 24 hr to determine of meat characteristics.

Drip loss

The breast meat samples were weighed, sealed in a plastic bag, and stored at 4 ^{O}C for 24 hr. The samples were weighed again, which was used to calculate the drip loss as a percentage of the initial weight.

Cooking loss

The cooking loss was measured on breast meat samples of about 20 g sealed in a plastic zip-lock bag and placed in a water bath until the internal temperature of samples reached 80 ^{O}C for 10 min and weighed the cooked breast and thigh meat after cooling and drying. Cooking loss was shown as a percentage relative to the initial weight.

Color measurements

Breast and thigh meat color were measured at 24 hr post-mortem with the ColorFlex® EZ spectrophotometer (Hunter Associates Laboratory, Inc., Virginia, USA) for CIE L*a*b* value (L* = lightness; a* = redness; and b* = yellowness).

Sensory evaluation

Sensory panel tests were performed on the breast and thigh samples, boiled without salt or seasoning. The cooked samples were cut into small pieces of 1.0×2.0×0.5 cm and randomly offered to 20 semi-trained participants. Five sensory parameters included tenderness, odor, flavor, juiciness, and overall acceptability, which were scored on a 9-point Hedonic scale (1 being extremely dislike to 9 extremely like).

Statistical analysis

All observation in each parameter were subjected to two-way analysis of variance as a completely randomized design to assess the effects of breed, sex, and their interaction, using the SPSS (15.0) for window 2006 statistical package. The effect means were compared for parameter where effects

difference was found significant by the used of Least Square Difference (LSD) method to determine the level of significance.

Result

Carcass yield

The results of carcass characteristics of Thai indigenous chickens raised in the organic system are shown in Table 2. The significant effects ($p<0.01$) of sex were observed on breast ($p<0.01$), and drumstick ($p<0.05$) percentage. Female chickens had significantly higher breast percentage, but lower drumstick percentage compared to the male ones. Only thigh percentage was significantly affected by breed, with LK having the higher values ($p<0.01$). No interaction between the breed and sex was found in any of the carcass yield parameters.

Table 2. Mean (±SD) carcass characteristics as influenced by breed and sex of Thai indigenous chickens reared in the organic system

Item	Carcass	Breast	Thigh	Drumstick	Wing	Liver	Heart	Gizzard
Breed[1]								
PD	70.0±2.41	12.66±1.59	9.58±0.90	11.31±0.92	9.90±0.45	1.92±0.29	0.50±0.08	2.45±0.32
LK	69.59±2.87	13.14±0.85	10.53±0.55	11.32±0.7	9.55±0.42	1.79±0.15	0.53±0.07	2.45±0.34
Sex[2]								
M	69.17±2.99	12.12±1.14	10.17±1.0	11.63±0.89	9.81±0.44	1.86±0.31	0.53±0.06	2.36±0.25
F	70.46±2.09	13.60±0.89	9.94±0.75	11.01±0.41	9.63±0.48	1.86±0.13	0.50±0.07	2.55±0.37
p-value								
Breed	0.677	0.259	0.006	0.982	0.073	0.155	0.398	0.995
Sex	0.254	0.001	0.479	0.046	0.323	1.00	0.370	0.183
B×S[3]	0.906	0.341	0.385	0.439	0.533	0.46	0.318	0.613

[1]/ PD -Pradu-hangdum, LK – Lueng-hangkhao, [2]/ F-Female, M-male, [3]/ B×S-Breed×Sex

Meat quality

The analysis of variance revealed no significant ($p>0.05$) effect of breed and sex as well as interaction of this factor on drip loss percentage. However, the cooking loss percentage were significantly ($p<0.01$) affected by breed. The results revealed that the cooking loss of LK chicken meat of 36.45 percent was higher than 30.86 percent of PD chicken meat (Table 3).

Table 3. Mean (±SD) drip loss and cooking loss as influenced by breed and sex of Thai indigenous chickens reared in the organic

Item	Breed1		Sex		p-value		
	PD	LK	Male	Female	Breed	Sex	B×S[2]
Drip loss (%)	1.25±0.09	1.30±0.18	1.26±0.12	1.29±0.17	0.570	0.747	0.498
Cooking loss (%)	30.86±1.44	36.45±2.07	32.83±3.02	34.48±3.66	0.001	0.066	0.516

[1]/ PD -Pradu-hangdum, LK – Lueng-hangkhao, [2]/ B×S-Breed×Sex

The average breast and thigh meat color values are shown in Table 4. It was determined that the influence of the breed on lightness and redness of breast and thigh was statistically ($p<0.01$) significant. LK breed showed higher L* values of breast and thigh meat than PD, on the contrary, PD breed exhibited higher a* of breast and thigh meat than LK breed (Table 4). Only the yellowness of thigh meat was affected by sex ($p<0.05$). Male chicken had a higher b* value of thigh meat than female. Additionally, significant interaction ($p<0.05$) between the breed and sex was found in the brightness of thigh meat and the yellowness of breast meat.

Table 4. Mean (±SD) breast and thigh meat color as influenced by breed and sex of Thai indigenous chickens reared in the organic system

Item	Part	Breed1		Sex		p-value		
		PD	LK	Male	Female	Breed	Sex	B×S
L*	Breast	59.74±3.52	64.75±4.61	61.48±4.00	63.01±5.41	<0.001	0.095	0.327
	Thigh	60.91±2.45	64.95±3.17	62.93±2.85	62.93±4.04	<0.001	0.998	0.036
a*	Breast	7.60±1.61	5.96±1.77	6.65±2.07	6.91±1.68	<0.001	0.498	0.785
	Thigh	7.53±1.12	6.28±1.44	6.79±1.45	7.03±1.41	<0.001	0.411	0.858
b*	Breast	16.44±1.93	15.69±2.58	16.20±2.74	15.93±1.73	0.137	0.592	0.039
	Thigh	13.88±2.97	13.89±3.49	14.61±3.45	13.16±2.83	0.994	0.047	0.699

[1]/ PD -Pradu-hangdum, LK – Lueng-hangkhao, [2]/ B×S-Breed×Sex

Sensory evaluation

The results of sensory evaluation of organic chicken meat are shown in Table 5. The statistical analysis revealed no significant ($p>0.05$) effect of breed and sex as well as interaction of this factor on color, odor, tenderness, and flavor of breast and thigh meat. Only overall acceptability of thigh meat was

affected by interaction between breed and sex. The lowest overall acceptability was found in LK female thigh meat (4.47), while the highest acceptability was obtained by the PD male (5.27).

Table 5. Mean (±SD) sensory attribute as influenced by breed and sex of Thai indigenous chickens reared in the organic system

Item	Part	Breed[1]		Sex		p-value		
		PD	LK	Male	Female	Breed	Sex	B×S[2]
Color	Breast	4.80±1.21	4.97±1.19	4.83±1.21	4.93±1.20	0.599	0.752	0.916
	Thigh	4.67±1.06	4.30±1.05	4.57±1.07	4.40±1.07	0.191	0.550	0.719
Odor	Breast	4.90±1.30	4.57±1.07	4.70±1.17	4.77±1.22	0.287	0.831	0.394
	Thigh	4.43±1.07	4.50±1.00	4.33±1.06	4.60±1.00	0.804	0.323	0.218
Tenderness	Breast	4.63±1.16	5.03±1.45	4.73±1.31	4.93±1.34	0.249	0.563	0.699
	Thigh	4.80±1.40	4.27±1.39	4.47±1.43	4.60±1.40	0.149	0.716	0.467
Flavor	Breast	5.00±1.48	4.73±1.48	4.90±1.52	4.83±1.46	0.483	0.860	0.057
	Thigh	5.23±1.28	5.00±1.14	5.03±1.6	5.20±1.27	0.456	0.594	0.113
Overall acceptability	Breast	5.13±1.14	4.77±1.25	4.90±1.27	5.00±1.14	0.242	0.748	0.244
	Thigh	5.00±1.26	4.83±1.12	4.87±1.22	4.97±1.16	0.582	0.741	0.040

[1]/ PD -Pradu-hangdum, LK – Lueng-hangkhao, [2]/ B×S-Breed×Sex

Discussion

This study investigated the effects of breed, sex and its interaction on carcass composition and meat quality of chicken raised in organic system. The results of this study revealed no significant effect of PD and LK breed on percentage of dressing, breast, drumstick, wing, and edible giblets, which was also confirmed in a research of Kamporn *et al*. (2022). They reported that there was no significant difference ($p>0.05$) among Abor Acre, Ross308, and Cob500 broiler stains in carcass and major carcass part (breast, thigh, and drumstick) percentage. In addition, Fanatico *et al*. (2008) did not find a significant chicken genetic factor (slow- and fast-growing genotype) on carcass percentage. In contrary, the observed significant thigh percentage difference

between Thai indigenous chicken breeds in this study agreed to the finding of Abdullah *et al*. (2010) who found that the strains of broiler affected the leg cut percentage.

It is apparent that sex significantly influenced the major cut-up yield, females had higher ($p<0.01$) breast and lower ($p<0.05$) drumstick percentage compared to males. The findings agree with the results of Merkley *et al*. (1980), Bogosavljevic-Boskovic *et al*. (2006), Abdullah *et al*. (2010), and Kamporn *et al*. (2022) who demonstrated that female having the higher breast percentage and lower leg cut percentage compared to male within different strain. Bogosavljevic-Boskovic *et al*. (2006) concluded that the differences in carcass percentage in various available research were due to the effect of both genetic (breed or line hybrid) and non-genetic factors (raising system, nutrition, age of birds, body weight before slaughtering, dressed carcasses weights, manner of dissection, etc.)

The cooking loss of organic chicken meat this study ranged for male, and female were 32.83 and 34.48 percent, respectively. This result was similar to the report in the organic broiler chicken meat of 33 percent (Castellini *et al*., 2002), but higher than the range of 19 to 23 percent in other local breeds which were reported by Wattanachant *et al*. (2004). Chicken meat and skin color could be affected by various factors including genetics, myoglobin in muscle, final pH level and feeding (Fletcher, 1999, Rizzi *et al*., 2007). In this study, the difference in L* and a* of breast and thigh meat between PD and LK bird confirmed to the report of Jaturasitha *et al*. (2008) Puchała *et al*. (2015) and Sosnówka-Czajka *et al*. (2017) who indicated that the chicken genetic differs in breast and leg meat color. However, the breed difference, as the lower L* and higher a* might be due to higher myoglobin content in the breast and meat of the PD chicken. Additionally, the significant breed×Sex interaction on lightness of thigh meat and yellowness of breast meat were similar to the finding of Kamporn *et al*. (2022) who reported that the color meat was also affected by the interaction effect of breed and gender. As opposed to these results, Lopez *et al*. (2011) did not find a significant influence of the genotype and sex effect on chicken meat color.

The sensory evaluation is a useful tool for quality assessment of meat (Uhlířová *et al*. 2018). In this study, the average score for all sensory attributes were ranged from the values of 4.27 to 5.23 for both genotypes and sex evaluated. The significant effect of interaction between breed and sex were found in overall acceptability of thigh meat, as mean score of 5.26, 5.20, 4.73, and 4.46 for PD male, LK female, PD female, and LK male, respectively. Zaid *et al*. (2020) stated that aroma, chewiness, moistness, and flavor of free-range chicken meat had more intense than conventional chicken meat. However,

Kapkowska *et al*. (2011) indicated that the most crucial quality factor of meat which were influenced satisfaction of consumers is meat tenderness.

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