THE EFFECT OF REARING SYSTEMS ON CARCASS TRAITS AND MEAT QUALITY IN TAIWAN GAME HENS

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Abstract – The present study was conducted to evaluate the effect of cage, floor-pen and free-range rearing systems on the growth performance, carcass yield, meat composition, and physical properties of Taiwan game hens. Six hundred 1-day-old female chicks were raised on a floor pen until 8 weeks of age. On day 57, the 600 chickens were divided into three groups and randomly assigned to three treatments (cage, floor-pen and free-range). After the experimental period, the free-range group had the lowest body weight, average daily gain, abdominal fat, thigh part percentage and breast meat fat content. Toughness in the breast meat of the free-range group was significantly higher than that in the cage feeding group. Body weight, abdominal fat ratio, thigh part ratio and ash content of the free-range chickens were lower than those of the floor raised chickens. Moreover, the Taiwan game hens raised with the free-range feeding model displayed well-received carcass traits, meat quality, low abdominal fat and fat content in breast meat, making the free-range chickens healthier diet choices.

Key Words – Carcass trait, Game hen, Meat quality, Rearing systems

Ⅰ. INTRODUCTION

Taiwan native chickens represent a number of locally developed breeds favored by Taiwanese consumers, as in Japan. Taiwan game hens are one species of Taiwan native chicken and are the main source of chicken meat in eastern Taiwan. In general, the rearing period is longer (18-24 weeks) and the live weight is heavier for Taiwan game hens, when compared with other Taiwan native chickens. Floor and cage rearing are common models for meat-type chicken husbandry in Taiwan. Free-range feeding methods are specially used to raise game hens with good meat quality. In ranching, free-range livestock are permitted to roam without fences, as opposed to being confined in fenced pastures. Higher taste panel scores for juiciness, overall acceptability and higher percentages of breast and thigh meat for organically reared chickens than for conventionally reared chickens have been reported by Cheng *et al* [1]. Furthermore, they [1] found that free-range chickens had a significantly higher percentage of breast meat, crude protein content, meat shear force and chewiness, and significantly less crude fat content, meat L* value, hardness and fracturability than those of conventional chickens. The iron, zinc, crude protein, total collagen contents, and firmness of thigh meat of free-range chickens were significantly higher those of cage or floor treated chickens. Cheng *et al*. [1] indicated that consumers had traditionally favored free-range chickens with firm texture and high quality meat in Taiwan. Cage and indoor floor rearing systems are the main rearing methods because of the ease of mass production and management. However, these methods must be carefully considered from the point of view of animal welfare.

In summary, the aim of this study was to examine the effects of various rearing methods on growth performance, carcass and meat traits of Taiwan game hens

Ⅱ. MATERIALS AND METHODS

Animals and diets : Six hundred 1-day-old Taiwan game hen chicks were purchased from a breeding farm in Chang-Hua County and subsequently reared in an open-sided broiler house. The chickens were kept on a floor pen for 8 weeks and fed conventional country chicken starter from 0 to 4 weeks (crude protein (CP),

22.3%; metabolized energy (ME), 3,061 kcal/kg) and grower diet from 5 to 8 weeks (CP, 19.0%; ME, 3,005 kcal/kg) *ad libitum*. At 8 weeks, the game hens were divided into cage, floor, and free-range rearing models for a 12-week experiment. The cage-rearing method was used for a total of 200 chickens allocated into pentaplicates (8 cages per replicate) with 5 chickens in each cage, measuring 90 cm×45 cm×50 cm in size in a conventional open-sided broiler house. A further 200 chickens were used for the floor-pen rearing method. These chickens were reared in 5 pens in a conventional open-sided broiler house, with each pen measuring 2.5 m×4.0 m in size. Forty chickens were housed per pen. The free-range rearing method was used for the third group of 200 game hens, which were allocated into two replicates with 100 chickens in each outdoor region (10 m×20 m, 0.5 birds/m^2). Figure 1 shows the appearance of free-range game hens in Taiwan. Fences and netting were erected to prevent wild animal and birds entering. Dwarf elephant grass (Napiergrass Taishu No. 3) bred by the Taiwan Livestock Research Institute was planted for free intake. About one fifth of the area (4 m×4 m) was occupied by a shelter and perches. The chickens received natural light. Feed and water were provided *ad libitum*. Four regions were provided for rotation grazing for three weeks.

All game hens were provided with the same starter, grower and finisher diets and were fed according to the same management schedule as reported by Lin *et* al. [2]. The body weight, feed intake, feed conversion ratio and mortality were recorded during the feeding period.

Sample preparation: After 24 h of feed deprivation, 24 sample game hens at 20 weeks of age from each group were weighed. Weights obtained prior to and during the processing procedure included evisceration, abdominal fat, thigh part and breast (*Pectoralis major*) part weight for each chicken. The dressing percentage was the ratio of the eviscerated weight to body weight. Abdominal fat as a percentage of body mass was taken based on the fasting weight of the live chickens. Carcass parts as a percentage of the body mass were calculated by the eviscerated weight. The samples were collected from the breast muscle of carcasses. The meat was obtained 2 h after slaughter in a chilled room, packed in low-density polyethylene bags (LDPE) and kept at 4 ± 1°C for about 24 h. Then, the fat and connective tissue were removed and the meat samples were portioned, packed in LDPE bags and transferred to a freezer maintained at -20 ± 1°C until analysis. The meat samples were thawed at 4 ± 1°C for 12 h before analysis and ground in a mincer, packed in LDPE bags and stored in a refrigerator (4 ± 1°C) until required.

Proximate analysis: Moisture, fat, crude protein and ash contents were determined according to the method of AOAC [3]. The samples used in the study were all *Pectoralis major*. The moisture content was determined by oven drying. Crude protein was analyzed by Kjeldahl nitrogen estimation. Fat was determined by Soxhlet extraction with petroleum ether. The amount of total collagen was determined according to the method described by HILL [4]. Calories were calculated by the energy intensity factor

Drip loss and cooking loss analysis: Drip loss was determined according to the bag method of Honikel [5]. Meat samples about 2.5 cm thick were removed from the breast muscles of each chicken. Samples were suspended by string in an expanded bag. The samples were then suspended at 4°C for 48 h, at which time the surface was lightly blotted with a paper tissue and reweighed. Drip loss was then expressed as a percentage of the original weight of the breast muscle. Cooking loss was measured for breast muscles as reported by Florene *et al.* [6]. The meat samples were cooked in a plastic bag in a water bath at 85°C until they reached an internal temperature of 70°C (after about 25 minutes.).

Texture analysis: Texture analysis was determined by recording the cooked physical property of breast muscle. The meat samples were cooked in a plastic bag in a water bath at 85°C for 25 minutes. Mechanical assessment of firmness and toughness was performed for meat samples cooled to 20°C. Samples were cut into 2×1×1 cm cubes parallel to the longitudinal orientation of the muscle fibers. Texture Analyser

(TA.XT-Plus, Stable Micro Systems, UK) was used for the texture analysis.

Statistical analysis: The study was executed in triplicate. Data were analyzed using a general linear model in the SAS system [7]. When significant (P<0.05) differences were detected, means were separated using Least Squares Means and Tukey's honest significance test for unbalanced data analysis.

Ⅲ. RESULTS AND DISCUSSION

Carcass traits: The carcass trait results obtained from this experiment are presented in Table 1. The percentages of abdominal fat and thigh part were significantly lower in the free-range group than in the other groups (P<0.05). Cheng *et al*. [1] also reported that chickens raised with free-range or organic methods had lower percentages of abdominal fat. Moreover, the reduced percentage of thigh and abdominal fat in the free-range group might be probably due to increased exercise leading to reduced fat deposition in abdomen and thigh.

Meat composition and physical properties: Results of breast meat composition and physical properties in this study are displayed in Table 2. The crude fat content in the breast meat of cage and floor groups was significantly higher than that in the free-range group (P<0.05), while the free-range group had significantly higher content of total collagen in breast meat (P<0.05). Compared with the floor-reared group, the free-range group had a significantly lower content of ash in breast meat (P<0.05). However, the contents of moisture, crude protein and calorie in breast meat showed no significant differences among groups. These findings were consistent with the results obtained by Wang *et al*. [8], who found no differences in nutrient composition (moisture, crude protein, and crude fat) of breast meat among different raising systems. In contrast to the results from this study, Lin *et al*. [9] reported that the content of ash in breast meat of the free-range rearing treatment was lower than that of the floor rearing treatment. Such differences were attributed to increased physical activity of chickens raised with outdoor organic treatments that favored myogenesis over lipogenesis.

Table 1 Effect of the rearing systems on carcass traits of Taiwan game hens

Items	Cag	Floor	Free-range
Body weight (g)	2767±150^{a}	2759±162^{a}	2529±168^{b}
Eviscerated weight (g)	2242±128^{a}	2214±139^{a}	2028±144^{b}
Dressing percentage (%)	81.1±0.3	80.3±0.4	80.2±0.5
Abdominal fat ratio (%)	3.91±0.3^{a}	3.49±0.2^{a}	1.69±0.1^{b}
Breast part ratio (%)	28.3±0.3	28.5±0.4	29.2±0.5
Thigh part ratio (%)	29.4±0.2^{a}	29.5±0.2^{a}	28.6±0.3^{b}

$^{a, b}$ Means in the same row without the same superscript are significantly different (P<0.05).

Table 2 Effect of the rearing systems on meat composition and physical properties in Taiwan game hens

Items	Cage	Floor	Free-range
Moisture (%)	72.3±1.2	72.0±1.3	72.0±1.4
Protein (%)	25.5±1.1	25.4±0.9	25.3±1.0
Fat (%)	0.54±0.38^{a}	0.51±0.35^{a}	0.23±0.27^{b}
Ash (%)	1.51±0.20^{ab}	1.67±0.16^{a}	1.35±0.14^{b}
Calorie (kcal/100g)	146.5±6.5	144.8±7.0	144.5±6.0
Total collagen(mg/g)	1.22±0.71^{b}	1.63±0.75^{ab}	2.12±0.73^{a}
Drip loss (%)	3.42±0.52	2.83±0.48	2.34±0.54
Cooking loss (%)	19.54±1.62	18.63±1.76	20.02±1.82
Firmness (kg)	1.94±0.42	2.53±0.45	2.61±0.41
Toughness (kg)	3.43±0.63^{b}	5.23±0.66^{ab}	6.81±0.68^{a}

$^{a, b}$ Means in the same row without the same superscript are significantly different (P<0.05).

The drip loss and cooking loss: Breast meat did not differ significantly among the three groups. The firmness in breast meat could be as much as 34.5% in free-range group over the cage group. However, this was not enough to conclude there was a resulting difference among the treated groups. Compared with the cage-raised group, the free-range group had a significantly higher toughness in breast meat (P<0.05). Consumers generally prefer to eat tough and firm chicken meats in Taiwan and also in Japan, because the meat texture of this type of meat is suitable for cooking and for chicken soups. This was in agreement with reports by Cheng *et al*. [1] who showed no difference in water holding capacity and purge loss in breast meat between the free-range rearing group and the conventionally raised group. Therefore, it was reasonable to expect that free-range chickens had greater toughness in breast meat, which was associated with higher collagen content in this type of meat, compared

with the other groups. Collagen, an abundant connective tissue protein, contributes to variations in meat tenderness and texture.

Ⅳ. COCLUSION

The breast muscle of free-range game hens had lower fat, higher collagen contents, and better texture for firmness and toughness. These traits are shown to be well-received by the consumers in Taiwan who appreciate the high quality of free-range game hen meat and the additional benefit of improved animal welfare.

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