



Carcass Physical Features of Malagasy Chicken: Indigenous Race and Starbro Strain

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Abstract

This study aims to compare anatomies of Madagascar chickens (indigenous race and Starbro strain). With 8,262 individuals of either indigenous races or Starbro strain chickens raised in a suburban environment, the weights of different pieces of cut as well as the live weights before slaughter were determined. Results showed that breast development presents a positive linear relationship with thigh development for Starbro strain chickens (fast growing broiler) while the relationship between the two traits is negative for the indigenous races (slow growing chicken). Giblet proportions are similar between these two types of chicken. We found that slaughtering at 1,750g live weight (age 120 to 185 days) is profitable for indigenous race chickens (meat yield = 40.16%, breast yield = 18.10%, thigh yield = 20.15% and abdominal fat yield = 1.90%). For the Starbro strain, ideal weight at slaughter is 1,300-1,450 g, corresponding to 49 to 61 days of age (meat yield = 39.63%, breast yield = 17.85%, thigh yield = 20.27% and abdominal fat yield = 1.51%). The physical features of the cuts are similar between indigenous races and Starbro strain chickens.

Introduction

Meat provides our main protein supply. The meat production sector has experienced invigorating growth, notably in production, consumption, and world exchange since the mid-80's (FAO, 2000). The poultry industry has proved to be the most dynamic amidst the different meat producing sectors with a yearly expansion of about 5.6% (Devine, 2003). Starting in 2002, poultry meat overran beef to arrive second in world meat consumption (after pork) (Devine, 2003).

Production intensification, industry vertical integration, and price levels were key factors contributing to this development. Farmers aim

to supply the necessary quantity to satisfy market demand. On the other hand, meat processors ensure quality is maintained for the sake of consumer wellbeing (ENVT, 2000; INRA, 2000). Therefore, market and offer segmentations, and cut and processed product are important in the progression as well as market development and evolution, and require good control (Devine, 2003). In Madagascar, poultry farming is not a dominant activity of the agricultural economy and does not have quantitative data that support the national economic system (Gama Consult, 2004; Sonalya & Swan, 2004; FOFIFA, 2006). However, poultry

production provides 20% of daily consumed animal proteins in Madagascar (FOFIFA, 2006), even though national meat consumption remains low (0.8 g per person daily *vs.* 11.9 g per person per day for the world average) in spite of booming modern suburban poultry farming (Albert *et al.*, 2003; France Diplomatie, 2006).

Thus, this study aims to improve knowledge about poultry production efficiency through analyses of the physical features of poultry meat intended for consumption in Antananarivo, Madagascar. These data can be used to create a better strategic orientation geared towards revival of the poultry industry in Madagascar.

Materials and Methods

Data have been gathered from various suburban poultry farms or from different butchers in downtown Antananarivo, Madagascar between November 2006 and April 2007. In total, 8,262 chickens were counted, of which comprised 1,309 individuals of indigenous race and 6,953 Starbro strain chickens. Indigenous race chickens have been raised in an extensive way, but still benefit from a feed supplement at the end of the day while chickens of Starbro strain have been raised more intensively and received a balanced ration twice daily. Farmers took care of the birds' sanitary follow-ups all throughout the production cycle. Cycle length varies from 40 to 61 days for Starbro strain chicken *vs.* 100 to 186 days for indigenous race chickens. A precision scale with a 3 kg range and 1 g precision was used to weigh chicken individually before slaughter and also the pieces of cut after slaughter. JMP/SAS 5.0.1 software was used for data statistical analyses.

In general, chickens are slaughtered the same day they are sold, or the evening before if demand is high. For the latter, carcasses are frozen in whole at night. Chicken live body weights as well as weights of various parts such as thigh, wing, breast, liver and abdominal fat were individually measured.

Elementary descriptive statistical analyses provide a synthetic data presentation along with cut and breast weights by class of chicken live weight qualitative. Comparative analyses were used to show differences between chickens of indigenous race and Starbro strain (Vessereau, 1988; Dagnelie, 1986; SAS/JMP, 2002).

The ratio between thigh weight (as well as wing, liver and abdominal fat weights) and breast weight was computed to demonstrate

tendency for noble piece weight evolution according to the class of live weight for each chicken type with eq. (1):

$$\text{Ratio} = \frac{\text{Thigh Weight}}{\text{Breast Weight}} \times 100 \text{ (Equation 1)}$$

Breast weight variation in relation to weight of edible meat (thigh, wing, and breast) for each class of live body weight was estimated using eq. (2):

$$\text{Ratio} = \frac{\text{Breast Weight}}{\text{Edible Meat Weight}} \times 100 \text{ (Equation 2)}$$

A similar calculation was used to assess slaughterhouse giblets (liver and abdominal fat) weight variation in relation to the weight of edible meat for every class of live body weight using eq. (3):

$$\text{Ratio} = \frac{\text{Slaughterhouse Giblet Weight}}{\text{Edible Meat Weight}} \times 100 \text{ (Equation 3)}$$

Productivity was assessed in two ways: chicken meat yield for live weight using eq. (4):

$$\text{Meat Yield} = \frac{\text{Thigh Weight} + \text{Breast Weight} + \text{Abdominal Fat Weight}}{\text{Live Weight}} \times 100 \text{ (Equation 4)}$$

and through a piece of cut weight ratio using eq. (5):

$$\text{Piece of Cut Ratio} = \frac{\text{Piece of Cut Weight}}{\text{Live Weight}} \times 100 \text{ (Equation 5)}$$

Results and Discussion

Population characteristics

Individuals weighing 1,300-1,450 g (class 4) are the most common for both the indigenous race (31.55%) (Table 1) and the Starbro strain (28.43%) (Table 2). Based on chicken breast weight, identified as a noble piece of meat, the ratio of the weight of pieces such as wings, liver, and abdominal fat over breast weight is similar between the two strains of chicken (indigenous race and Starbro). In contrast, a peak of the ratio between thigh weight over breast weight (Eq. 1) is noted for class 6 (1.17 for indigenous race chickens and 1.15 for Starbro strain chickens) (Fig. 1). However, among the indigenous race, chickens with a live weight over 1750 g live weight have a relative reduction in thigh weight compared to breast weight: ratios of 1.11 and 1.05 for class 7 and class 8 of chicken live weight, respectively. This relative reduction of the ratio between thigh and breast weights is not observed in Starbro strain chicken (ratios of 1.12

and 1.14 for classes 7 and 8, respectively). These observations show that fast growing chicken have proportional development in their breast and thigh, but slow growing strains, especially over 1750 g live weight, breast development takes place at the expense of thigh weight increase.

In regards to the relative breast weight over total edible meat weight (thigh, wing, and breast), this ratio (Eq. 2) first increased with live weight for Starbro strain chicken and then reached a plateau at a value slightly lower than

39% for class 5 (live weight 1450-1,600 g) (Fig. 2). Comparatively, for the indigenous race, starting at class 6 (live weight 1,600-1,750 g), breast represents a relatively more important part of edible meat make up. This suggests that breast development may be more prominent than development of other pieces of meat in slow growing chicken. In contrast, for fast growing strains, the different piece of meat proportions remains relatively free from live body weight effect.

Table 1. Indigenous race chicken physical features (n = 1309, mean±SE)

(Class) (Live body Weight, g)	(1) (850-1000)	(2) (1000-1150)	(3) (1150-1300)	(4) (1300-1450)	(5) (1450-1600)	(6) (1600-1750)	(7) (1750-1900)	(8) Live Weight>1900
Rearing period (day)	120-185	120-185	100-186	100-186	100-184	110-183	120-185	127-180
Number of birds	64	131	309	413	252	63	63	14
Frequency (%)	4.89	10.01	23.61	31.55	19.25	4.81	4.81	1.07
Thigh (g)	181.58±2.13	214.11±1.49	246.22±0.97	279.49±0.84	304.81±1.07	343.67±2.15	364.67±2.15	377.00±4.55
Based on Eq. 1 (%)	121.09	116.8	114.1	113.54	113.22	117.74	111.33	105.75
Wing (g)	75.22±1.02	86.92±0.72	99.49±0.47	110.12±0.40	121.53±0.52	135.33±1.03	147.89±1.03	148.50±2.19
Based on Eq. 1 (%)	50.16	47.42	46.11	44.73	45.14	46.36	45.15	41.65
Breast (g)	149.95±3.20	183.31±2.24	215.79±1.46	246.17±1.26	269.22±1.61	291.89±3.22	327.56±3.22	356.50±6.84
Liver (g)	26.5±0.57	30.26±0.40	32.30±0.26	36.61±0.22	38.61±0.29	42.89±0.58	48.67±0.58	61.00±1.22
Based on Eq. 1 (%)	17.67	16.51	14.97	14.87	14.34	14.69	14.86	17.11
Abdominal fat (g)	9.94±0.89	13.04±0.62	14.61±0.40	20.95±0.35	23.50±0.45	23.67±0.89	34.44±0.89	31.50±1.90
Based on Eq. 1 (%)	6.63	7.11	6.77	8.51	8.73	8.11	10.51	8.84
Meat yield (%)	36.37±0.85	37.60±0.93	38.76±1.06	39.61±1.23	39.50±1.29	39.19 ± 1.51	40.16 ± 1.86	39.33±8.70
Thigh yield (%)	19.34±0.33	19.61±0.42	20.02±0.36	20.25±0.42	20.15±0.46	20.43 ± 0.57	20.15 ± 0.55	19.38±2.10
Breast yield (%)	15.97±0.44	16.79±0.39	17.55±0.55	17.84±0.61	17.79±0.64	17.35±0.77	18.10±1.07	18.33±6.15
Abdominal fat yield (%)	1.06±0.09	1.19±0.12	1.19±0.15	1.52±0.20	1.55±0.19	1.41±0.17	1.90±0.24	1.62±0.45

Weights of slaughterhouse giblets (liver and abdominal fat) relative to edible meat weight (Eq. 3) are similar between the two types of chicken (Figure 3). For class 6 chickens (live weight 1600-1750 g), the relative weight of slaughterhouse giblets tends to increase, especially for indigenous race chicken, where it increases over 10% of edible meat weight in chickens of class 8 (>1900 g). In this study, indigenous race chicken (raised on an extensive mode) and Starbro strain chicken (raised on a more intensive system) show similar growth performance patterns. Likewise, liver and abdominal fat development are not directly related to chicken edible meat quantity in neither fast growing nor slow growing race or strain. Thus, it is noted that chickens show the

same tendency in body development and piece of cut weight growth. The only significant difference stands in the relative predominance of breast piece in indigenous race chicken during the finishing growth phase. Beside herd size effect on chicken performance level (Delpech, 1984), difference in age at slaughtering, the double for indigenous race chicken compared to that of Starbro strain chicken, would be the main factor (Castellini *et al.*, 2002; Baéza *et al.*, 2003; Havenstein *et al.*, 2003; Cortinas *et al.*, 2004; De Marchi *et al.*, 2005). Indeed, chicken body growth and development follow physiological rules established during embryonic development (Romanoff, 1960; Mauro, 1961; Moss, 1968; Moss and Leblond, 1971; Kang *et al.*, 1985; Ott *et al.*, 1990; Murakami *et al.*, 1992; Halevy *et al.*, 2000;

Mozdziak *et al.*, 2002; Berri and Duclos, 2003; Goll *et al.*, 2003; Picard *et al.*, 2003; Velleman, 2007). Abdominal fat deposit is not directly related to chicken muscular growth, but is often significantly affected by raising management, particularly the bird feeding system (Gunaratne *et al.*, 1993; Gunaratne *et al.*, 1994; Gunaratne, 1999; Huque, 1999a; Huque, 1999b; Roberts, 1999; Ndegwa *et al.*, 2001; Dana and Ogle, 2002; Olukosi and Sonaiya, 2003; De Marchi *et al.*,

2005; Gondwe and Wollny, 2005), the animal genetic features (Leclercq, 1983; Ricklefs, 1985; Leclercq, 1989; Leclercq *et al.*, 1994; Mitchell and Burke 1995; Duclos and Rémignon 1996; Duclos *et al.*, 1996; Alleman *et al.*, 1999; Halevy *et al.*, 2000; Bigot *et al.* 2001; Havenstein *et al.*, 2003; Cortinas *et al.*, 2004) and lastly, respect for the farming environmental conditions (Blake and Hess, 2004).

Table 2. Starbro strain chicken physical features (n=6953, mean±SE)

(Class) (Live body Weight, g)	(1) (850-1000)	(2) (1000-1150)	(3) (1150-1300)	(4) (1300-1450)	(5) (1450-1600)	(6) (1600-1750)	(7) (1750-1900)	(8) Live weight>1900
Rearing period (day)	40-61	40-61	49-61	49-61	49-61	49-61	49-61	49-61
Number of birds	340	762	1725	1977	1296	449	338	66
Frequency (%)	4.89	10.96	24.81	28.43	18.43	6.46	4.86	0.95
Thigh (g)	181.24±0.95	212.16±0.63	245.64±0.42	279.80±0.39	304.88±0.49	338.57±0.83	364.41±0.95	371.59±2.15
Based on Eq. 1 (%)	120.43	115.27	114.52	113.53	113.01	115.35	112.51	114.52
Wing (g)	75.04±0.48	86.26±0.32	98.26±0.21	110.18±0.20	121.38±0.24	132.81±0.42	146.57±0.48	148.44±1.08
Based on Eq. 1 (%)	49.86	46.87	45.81	44.71	44.99	45.25	45.25	45.75
Breast (g)	150.49±1.37	184.06±0.91	214.50±0.61	246.45±0.57	269.79±0.70	293.52±1.19	323.90±1.37	324.48±3.11
Liver (g)	26.46±0.25	29.97±0.17	32.10±0.11	36.56±0.11	38.70±0.13	42.14±0.22	48.05±0.26	53.26±0.58
Based on Eq. 1 (%)	17.58	16.28	14.97	14.83	14.34	14.36	14.83	16.41
Abdominal fat (g)	10.08±0.40	13.18±0.27	14.51±0.18	20.90±0.17	23.27±0.21	26.19±0.35	34.13±0.40	30.29±0.91
Based on Eq. 1 (%)	6.7	7.16	6.76	8.48	8.63	8.92	10.54	9.33
Meat yield (%)	36.45±0.87	37.68±1.01	38.64±1.07	39.63±1.20	39.48±1.32	39.16±1.86	39.84±1.83	37.66±4.57
Thigh yield (%)	19.33±0.32	19.52±0.46	19.20±0.36	20.27±0.42	20.13±0.49	20.14±0.64	20.10±0.53	19.27±0.98
Breast yield (%)	16.05±0.46	16.94±0.44	17.46±0.56	17.85±.59	17.81±0.64	17.46±0.85	17.86±1.07	16.82±3.17
Abdominal fat yield (%)	1.08±0.09	1.21±0.12	1.18±0.15	1.51±0.19	1.54±0.19	1.56±0.37	1.88±0.23	1.57±0.43

Meat Yield

Meat yield (Eq. 4) (Fig. 4) and the partial piece of cut yield (Eq. 5) (Fig. 5) are reflections of chicken production performance. Meat yield (Eq. 4) was similar between the two chicken populations. A progressive increase in meat yield is noted from live weight class 1 (36.37% for indigenous race chicken *vs.* 36.45% for Starbro strain) up to class 4 (39.61% *vs.* 39.63%, respectively for the indigenous race and Starbro). A maximum yield is noted at class 7 level among indigenous race (40.16%) or among Starbro strain (39.84%). There are no significant differences in the ratios of piece of cut of different live weight classes of chickens (Eq. 5) ($P > 0.05$) (Fig. 5a and Fig. 5b), demonstrating that age at slaughtering does not impact ratios

and yields in indigenous race nor Starbro strain chickens. However, it could be noted that slaughtering of indigenous race chickens may be most beneficial at class 7 (live weight 1750-1900 g) (Figure 5a) as breast ratio is higher (18.10%) compared to that of class 6, even if thigh ratio (20.15%) is slightly lower than that of class 6 (20.43%). Slaughtering of the Starbro strain would be most profitable in class 4 chickens (live weight 1300-1450 g) (Figure 5b) as thigh ratio (20.27%) and breast ratio (17.85%) are higher. Variations in ratios may be due to effects of age at slaughtering, genetic makeup, and physiological state (Delpech, 1984; Tor *et al.*, 2002; Baéza *et al.*, 2003).

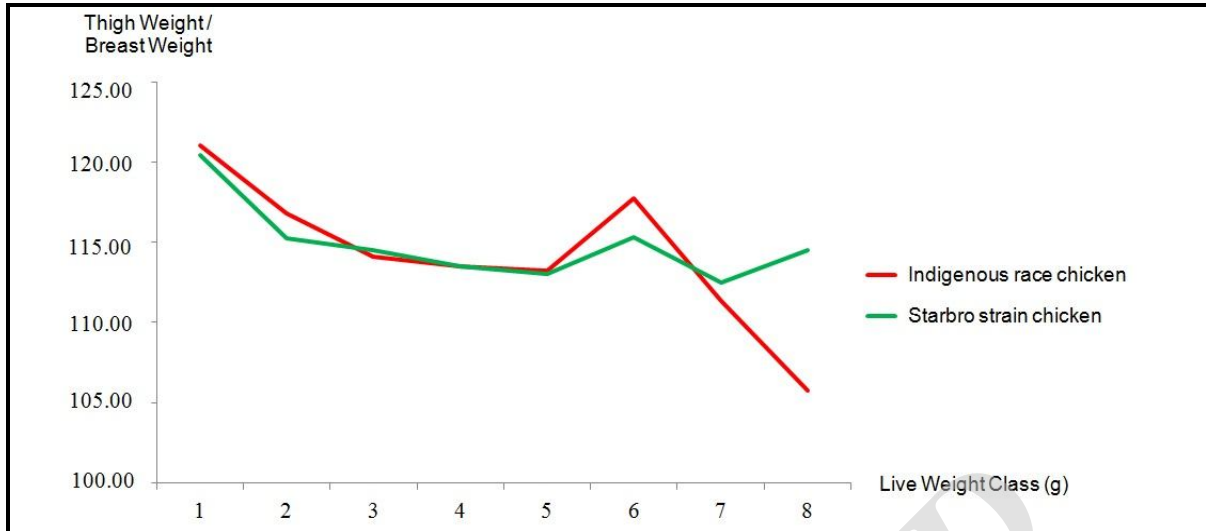


Figure 1. Ratio between Thigh Weight and Breast Weight evolution with chicken Live Weight Class.

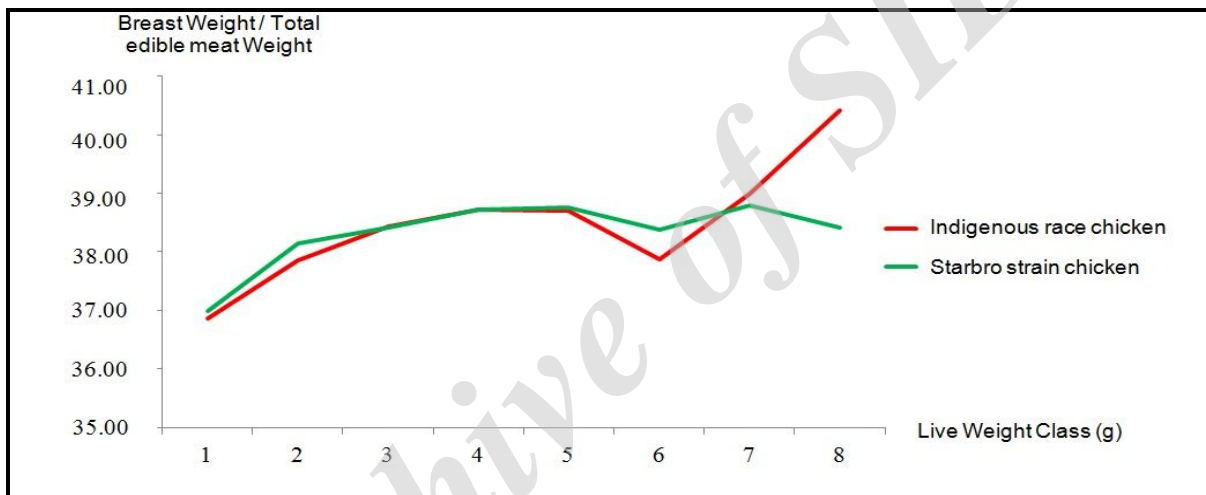


Figure 2. Ratio between Breast Weight and Carcass Weight evolution with chicken Live Weight Class.

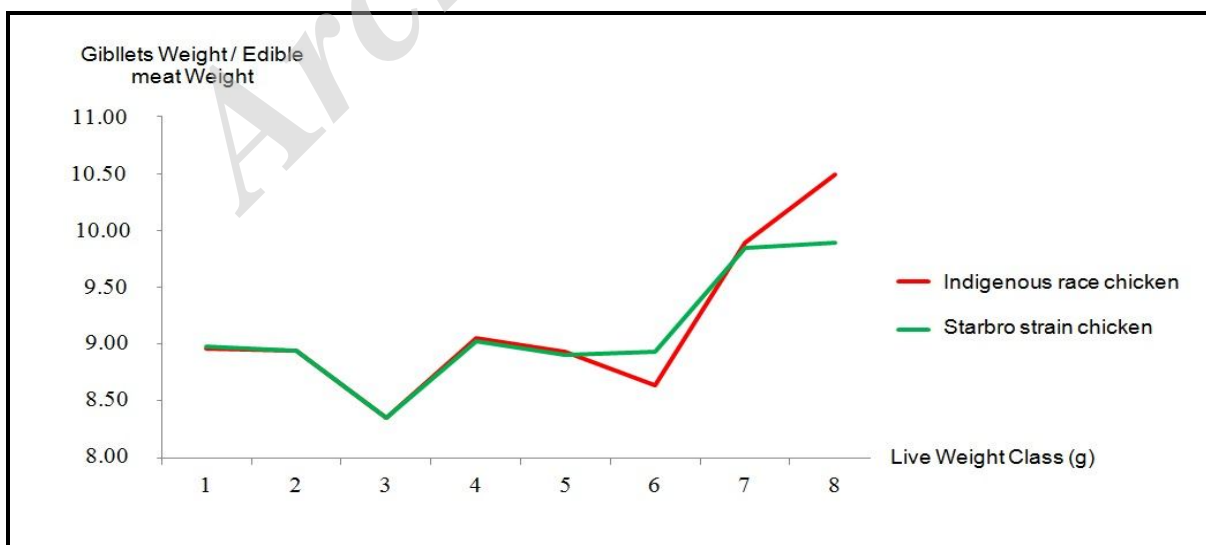


Figure 3. Ratio between Slaughterhouse Giblet Weight and Carcass Weight evolution with chicken Live Weight Class.

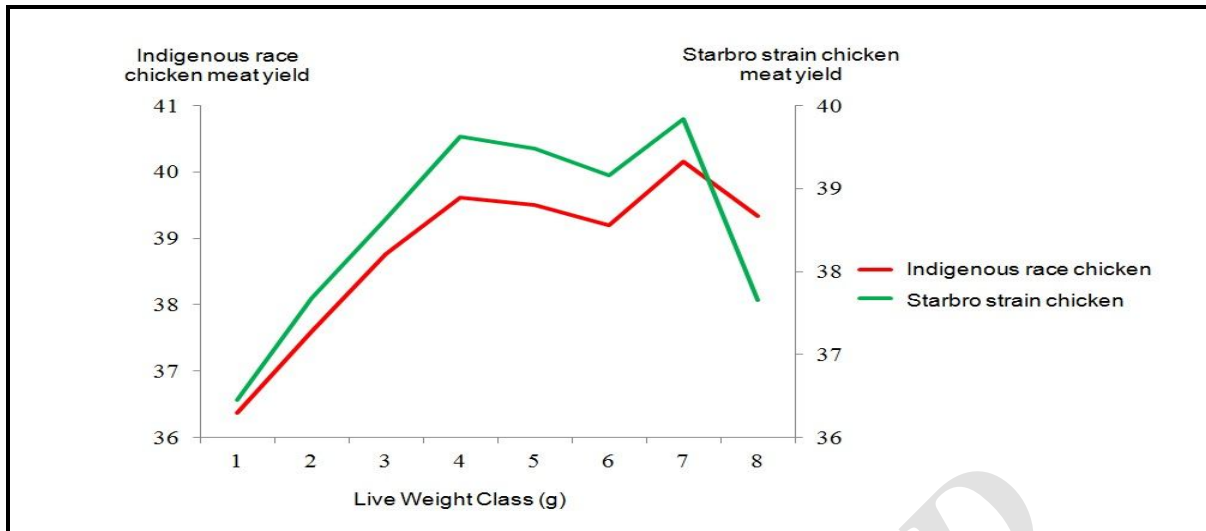


Figure 4. Chicken meat yield evolution with live weight class.

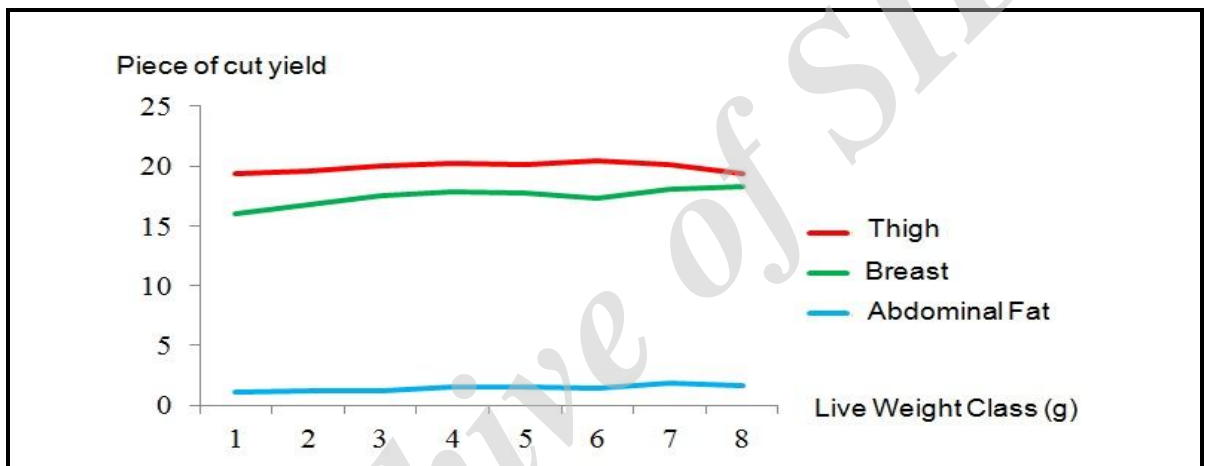


Figure 5a. Indigenous race chicken piece of cut ratio evolution with live weight class.

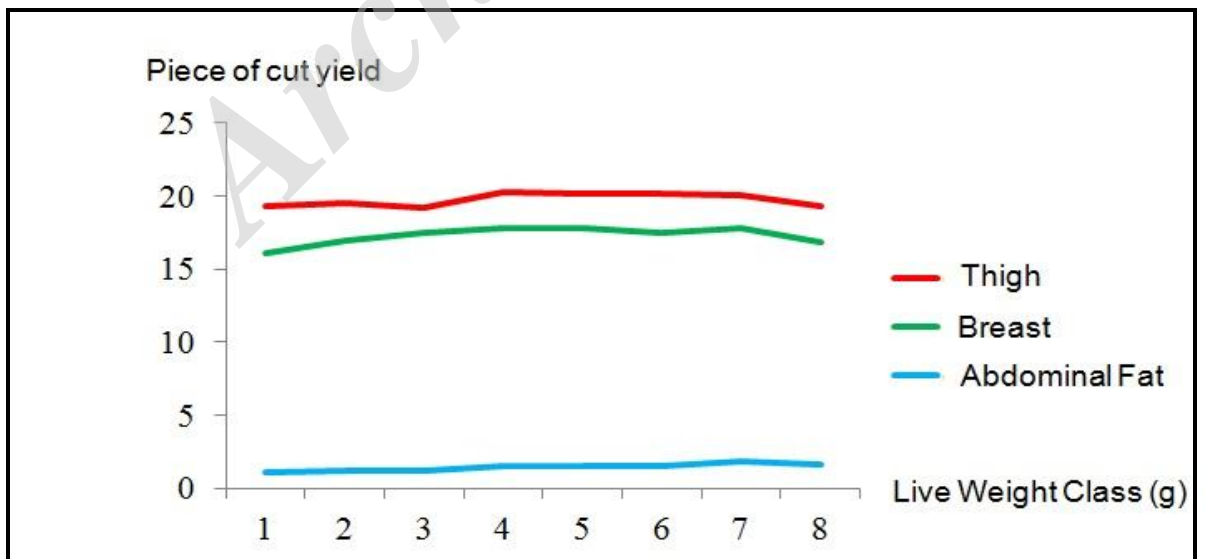


Figure 5b. Starbro strain chicken piece of cut ratio evolution with live weight class.

Conclusion

Two different chicken populations - a fast growing one (Starbro strain) and a slow growing other (indigenous race) - have been studied. Despite being raised in two different systems, physical features of the piece of cut were similar between the two populations. A low growth performance leading to low production efficiency is noted for the whole population. Improving farming techniques and management would increase size of

edible meat. However, for better production, setting up a management and decision-making help tool is recommended, especially for revival of the poultry sector with indigenous race chickens.

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بررسی فیزیکی ترکیب لاشه مرغ ماداگاسکار: نژاد بومی و سویه استاربرو

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چکیده

این مطالعه به منظور مقایسه ریخت‌شناسی مرغ ماداگاسکار (نژاد بومی و سویه استاربرو) انجام شد. تعداد ۸۲۶۲ قطعه مرغ از نژاد بومی و سویه‌ی استاربرو پیش از کشتار توزین و وزن ترکیبات لاشه آن‌ها توزین شد. نتایج آزمایش نشان داد که در سویه‌ی استاربرو (مرغ پررشد) وزن سینه همبستگی مثبتی با وزن ران داشت در حالی که همبستگی بین این دو صفت در نژاد بومی (مرغ کم رشد) منفی بود. ارتباط بین اندام‌ها در این دو گروه از مرغ‌ها مشابه بود. نسبت احشاء در دو نژاد مرغ مشابه بود. ما دریافتیم که برای نژاد بومی کشتار با وزن ۱۷۵۰ گرم سودمند است (تولید گوشت ۴۰/۱۶ درصد، بازده سینه ۱۸/۱۰ درصد، بازده ران ۲۰/۱۵ درصد و بازده چربی حفره بطنی ۱/۹۰ درصد). در سویه‌ی استاربرو وزن مطلوب کشتار ۱۴۵۰ - ۱۳۰۰ گرم در سنین ۴۹ تا ۶۱ روزگی است (تولید گوشت ۳۹/۶۳ درصد، بازده سینه ۱۷/۸۵ درصد، بازده ران ۲۰/۲۷ درصد و بازده چربی حفره بطنی ۱/۵۱ درصد). خصوصیات ریخت‌شناسی ترکیب لاشه در بین نژاد بومی و سویه‌ی استاربرو مشابه بود.

کلمات کلیدی

ماداگاسکار
قطعه‌بندی
سویه استاربرو
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