ESTIMATION OF HERITABILITIES FOR MEAT QUALITY TRAITS IN KOREAN NATIVE CHICKEN

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Abstract – The aim of this study was to estimate the heritabilities for meat quality traits in Korean native chicken in order to further use for identifying QTL and causative mutations. We measured 45 meat quality traits including physical, chemical and biochemical traits in 88 F_0 and 595 F_1 birds from five lines of Korean native chicken [Black: 90, Grey-Brown: 110, Red-Brown: 136, White: 126, and Yellow-Brown: 133] . Two models, with and without line effects, were applied to estimate heritabilities. The results revealed that line effect was strongly affected heritability estimates in slaughter weight, breast inosine, leg carnosine, leg inosine, and breast yellowness of meat (b*). Without line effect, their heritability estimates were ranged from moderate (0.2) to high (0.66). On the other hand, h^2 of those traits were decreased when line effect was included in the model. In conclusion, the line effect strongly affected heritability estimates for some of meat quality traits in the Korean native chicken population. These results can be used for genome-wide variance component linkage analysis to identify QTL and association study to detect causative mutations in the future.

Key Words – Heritability, Korean native chicken, Meat quality

• INTRODUCTION

Consumption of white meat has been increasing rapidly which covers more than twenty percent of total meat consumption in Korea [1]. In 1994, National Institute of Animal Science (NIAS) launched Korean native chicken (KNC) conservation project and as the results, five lines of KNC were developed. They were classified based on plumage colors namely Red brown, Yellow brown, Black, White and Gray [2].

Nowadays, native chickens are more preferred by consumers because they have good quality of meat which contains low fat, high levels of protein and unsaturated fatty acids [3]. Previous study reported that selection pressure for high growth in chicken may cause decrease meat quality. Histological and biochemical modifications of the muscle tissue were also affected by genetic improvement in meat-type chicken [4]. Furthermore, these modifications have affected some meat quality problems including toughness and poor cohesiveness, colour, and water holding properties during processing and storage [5]. Recently, marker-assisted selection has been used for genetic improvement in poultry breeding by using QTL and/or commercially available large scale chicken SNP chip analysis [6,7]. Therefore, the purposes of this study were to estimate heritabilities for meat quality traits in Korean native chicken in order to use them for tracing QTL and causative mutations in the future.

• MATERIALS AND METHODS

Animals

Total 88 parent (F_0) and 597 F_1 birds from five lines of Korean native chicken from 70 full-

sib families were raised in the Poultry Division at National Institute of Animal Science (NIAS), Korea. Chickens were fed *ad libitum* with commercial formulated feed with 18.2% concentrated protein and 2859 kcal/kg metabolizable energy (ME) for 20 weeks. All animals were fed in reduced environmental variation and used same feeding plan.

Measurement of Meat Quality Traits and Statistical Analysis

Meat quality traits were analyzed following standard protocols in the Laboratory of Meat Science at Chungnam National University, Korea. The data were analyzed to estimate heritabilities (h^2) using mixed animal models using Qxpak [8]. The heritabilities were estimated with the following two models:

$Y = \mu + S + L + B + RPC + \varepsilon$, and
$Y = \mu + S + B + RPC + \varepsilon$

Where, Y is observed phenotype, μ is overall population mean, S is sex, L is line, B is batch, RPC is random polygenic component, and ε is random error.

- RESULTS AND DISCUSSION

Estimation of heritabilities for meat quality traits in Korean native chicken was performed in this study. A total of 45 meat quality traits including physical, chemical, and biochemical traits were measured and their heritabilities were estimated (Table 1). Two models, with and without line effects, were applied to estimate the heritabilities. The results showed that the line effects affected strongly h^2, especially the traits having moderate to high heritabilities (Fig. 1). They are slaughter weight, breast inosine, leg carnosine, leg inosine, and breast yellowness (b*) and their heritability estimates were ranged 0.2 to 0.66 which is grouped as moderate to high heritabilities [9,10]. Heritability estimates were generally decreased when the line effect was included in the model. In general, if the h^2 estimates are lower than 0.2, this trait has low genetic effect and more controlled by the environmental factors, such as feeding, management of chicken and handling carcass during and after slaughtering [11]. Previous study reported that body weight and meat color were highly heritable in chicken [9,10,12].

Table 1 Heritability estimates for meat quality traits in Korean native chicken

Trait	h^2 with Line Effect	h^2 without Line Effect
Slaughter Weight (g)	0.235	0.597
Brst_Cholesterol (mg/g)	0.066	0.062
Brst_Creatine (mg/100 g)	0.034	0.094
Brst_Carnosine	0.039	0.036
Brst_Anserine (mg/100 g)	0.213	0.219
Brst_Dipep_Total (mg/100 g)	0.167	0.174
Brst_IMP (mg/100 g)	0.109	0.200
Brst_Hypoxanthine (mg/100 g)	0.026	0.049
Brst_AMP (mg/100 g)	0.013	0.068
Brst_Inosine (mg/100 g)	0.098	0.503
Leg_Cholesterol (mg/g)	0.065	0.062
Leg_Creatine (mg/100 g)	0.066	0.033
Leg_Carnosine (mg/100 g)	0.114	0.397
Leg_Anserine (mg/100 g)	0.029	0.075
Leg_Dipep_Total (mg/100 g)	0.126	0.133

Leg_IMP (mg/100 g)	0.067	0.053
Leg_Hypoxanthine (mg/100 g)	0.070	0.027
Leg_AMP (mg/100 g)	0.065	0.061
Leg_Inosine (mg/100 g)	0.005	0.368
Brst_WHC	0.066	0.066
Brst_H_2O	0.016	0.017
Brst_cProtein	0.068	0.066
Brst_cFat	0.066	0.066
Brst_cAsh	0.065	0.119
Brst_Collagen	0.067	0.066
Leg_WHC	0.064	0.061
Leg_H_2O	0.039	0.118
Leg_cProtein	0.068	0.091
Leg_cFat	0.065	0.066
Leg_cAsh	0.065	0.020
Leg_Collagen	0.066	0.088
Brst-Cookingloss	0.065	0.062
Brst-$pH_{15\ min}$	0.067	0.070
Brst-$pH_{ultimate}$	0.014	0.010
Brst-Delta_pH	0.038	0.088
Brst-L*	0.060	0.049
Brst-a*	0.062	0.053
Brst-b*	0.427	0.659
Leg-Cookingloss	0.032	0.059
Leg- $pH_{15\ min}$	0.068	0.053
Leg- $pH_{ultimate}$	0.032	0.087
Leg_Delta_pH	0.065	0.021
Leg-L*	0.045	0.167
Leg-a*	0.067	0.078
Leg-b*	0.066	0.011

Abbreviation: AMP: adenosine monophosphate, Brst: breast, IMP: inosine monophosphate, WHC: water holding capacity, L*: lightness, a*: redness, b*: yellowness

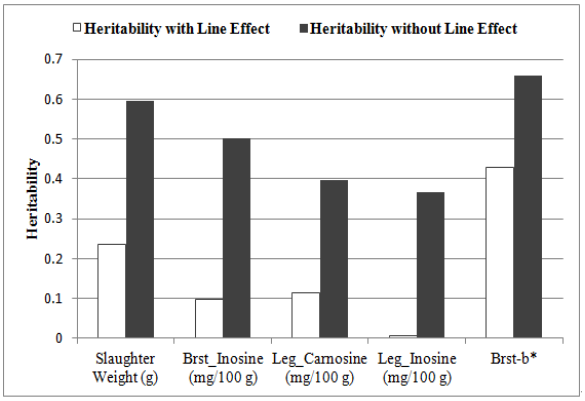

Figure 1. The heritability estimates for the six meat quality traits with and without line effects in the model

- CONCLUSION

In conclusion, the line effects were strongly affecting heritability estimates, especially for the

traits having high heritabilities in Korean native chicken. These results will be very valuable for genome-wide variance component linkage analysis in the future and also tracing causative mutations for meat quality traits in KNC.

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