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Variability of External Genetic Characteristic of Kokok Balenggek Chicken in West Sumatera, Indonesia

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Abstract: Kokok Balenggek chicken is one of the rare indigenous chickens in Indonesia. They are unique as they produce a melodious song like crow. They have syllabic diversity, as each portion of the call can be composed with different pitches and vocalizations. The identification and characterizations of local adorn chicken is very important for animal conservation. A research was conducted in west Sumatera to identify the genetic variability of the external genetic characteristic of Kokok Balenggek chicken. This research was conducted in a limited area of Solok district West Sumatera, Indonesia. About 203 (111 males and 92 females) Kokok Balenggek chicken were observed. The varieties are based on base colour of feather, colour of the plumage, flick feather, pattern of feather, shank colour and comb types. The method were used to analyze the rate of purity and native gene, the frequency of autosomal and sex-linked of the genes, feather pattern, rate of introgression from the exotic breed of Rhode Island Red, White Leghorn and of Barred Plymouth Rock. The research showed that the highest controlling genes characteristic external of kokok Balenggek chicken are coloured (ii), wild type pattern (e+), plain feather (ss) golden flick feather (ss), yellow shank coloured (ld_) and single comb (pp). A constitution on external genetic characteristic of Kokok Balenggek is ii e+ bbssld_pp. while The purity gene of Kokok Balenggek chicken has only 45.30%. Its genetic introgression is affected by the exotic breed from Europa and America with genetic introgression value of 0.5470. According to the rate of heterozygosity value of kokok Balenggek chicken varied within 29.41%. In conclusion, the Kokok Balenggek chickens show heterogeneity in the external genetic. To complete a set of their characterization further studies are needed on their quantitative traits and the molecular composition.

Key words: Variability, external genetic characteristic, Kokok Balenggek chicken, nice song

INTRODUCTION

Chickens are classified in the following order: Galliformes, family: Phasianidae and genus: Gallus (jungle fowl). Their domestication resulted in basic changes in the behaviour, physiology and production of the bird, but still there are some similarities between the current chickens and their ancestor (Al-Nasser *et al.*, 2007). It is widely believed that all populations of domesticated chicken descend from a single ancestor, the red jungle fowl (*Gallus gallus gallus*), which originated in Southeast Asia (Fumihito *et al.*, 1994, 1996). Romanov and Weigend (2001) states that *G gallus gallus* is the ancestor of all domestic chickens that developed nations now. Hillel *et al.* (2003) states that the red jungle fowl is a single common ancestor (single ancestor) and a major contributor to the gene pool all domestic chicken nation in the world.

Chicken is by far the most widely distributed of all livestock species in Indonesia. It plays a very significant role as a source of income and provides high quality protein to the rural households. Chicken rearing is relatively cheap so even the poor small holders can

afford to breed them. Native chicken appears to possess enormous genetic diversity especially in regard to its adaptive traits, ability to survive harsh conditions and under minimum feeding regimes. Chicken is by far the most widely distributed livestock. It is widely believed that all populations of domesticated chicken descend from a single ancestor, the red jungle fowl (*Gallus gallus gallus*), which originated in Southeast Asia (Fumihito *et al.*, 1994, 1996).

In Indonesia, the domestic (indigenous) chicken are scattered throughout the archipelago. Apparently they have a lot of diversity with different morphologic characteristics. The Indonesian native chicken apparently have species physical characteristic which differentiate them into at least 31 breeds or distinct groups of local chicken (Nataamijaya *et al.*, 1996; Nataamijaya, 2000). Two breeds of chicken are known as ornamental chickens because their voice are Kokok Balenggek and Pelung chicken. Most of the native chickens in Indonesia are raised under extensive traditional system where they are free to scavenge around farmer's house during the day and sleep

wherever they like to such as: on trees, in hollows spaces and even inside the villager's houses. Despite the introduction of exotic and crossbred types of chickens deep into rural areas, their productivity, even their existence is are questionable.

Kokok Balenggek chicken are unique because they produce a melodious song like crow. Have syllabic diversity, as each portion of the call can be composed with different pitches and vocalizations. They deserve to be conserved and developed as an indigenous germ plasma. Kokok Balenggek chicken is thought to be a derivative crosses the red jungle fowl (*Gallus gallus* G) with central areas of local chicken in the shifting cultivation area. This conjecture is based on the theory that the *G gallus gallus* located on the island of Sumatra (Nishida *et al.*, 1980; Fumihito *et al.*, 1994).

In the poultry field, identification and characterization efforts are prerequisites in utilization of genetic resources (Utoyo *et al.*, 1996; Weigend and Romanov, 2001). Characterization of indigenous livestock can be done in several ways, namely descriptions of phenotypic, genetic evaluation, DNA fingerprinting and karyotipe (Khumnirdpetch, 2002). The qualitative traits of the chickens also have important economic, cultural and religious function. Their specific characteristics must be carefully identified and considered in developing and breeding programs.

To study the existence and genetic improvement program in Indonesia, identification and characterization of Kokok Balenggek are required. The chicken identification can be done mainly on the phenotype, both qualitatively (feather colour, skin, shank and comb size) and quantitatively (morphometric, productivity and resistance to diseases or parasites). The descriptive phenotype identification is also required in order to identify their specific characteristics.

MATERIALS AND METHODS

In this research, 111 male and 92 female of Kokok Balenggek were used. These chickens were raised by

small holders in the Tigo Lurah Regency, Solok District of West Sumatera Province, Indonesia. This research utilized the survey method and intensive direct examination. In sample selection, the purposive sampling method was utilized. The variety on base color of feather, color of the plumage, flick feather, feather pattern, shank color and comb types of the chickens were identified based on Hutt (1949) and Somes (1988). The frequency of autosomal genes (plumage color and comb types), sex-linked genes (variety on base color of feather, flick feather and shank color) and feather pattern were quantified based on Nishida *et al.* (1980) and Stanfield (1982). The rate of introgression from exotic breed such as White Leghorn, Bared Plymouth Rock and Red Island Red and purity gen of Kokok Balenggek chicken were quantified based on Nishida *et al.* (1980). To examine the rate of genetic variability, the formula suggested by Hashiguchi *et al.* (1982) and Nei (1987) was used.

RESULTS

External genetic characteristic: External genetic characteristic including plumage color, shank color, comb type, of Kokok Balenggek chickens are presented in Table 1. Base on the result of this research, the external genetic characteristic of Kokok balenggek chickens were determined by color (ii) 96.55%, wild type pattern (e+) 66.01%, plain feather (ss) 60.10%, golden flick feather (ss) 71.43%, yellow shank coloured (Id_) 68.96% and single comb (pp) 99.01%. The gene frequency that controls the external genetic characteristic in Kokok Balenggek is presented on Table 2. Based on this research, the gene frequency that control the external genetic characteristic of Kokok balenggek chicken were dominated are coloured (ii) 0.9826, present of wild pattern or no uniformity (e+) 0.5283, plain feather (bb) 0.7430, golden flick feather (ss) 0.8041, yellow shank coloured (Id_) 0.5470 and single comb (pp) 0.9951. Based on the controls of gene constitution on external genetic characteristic of Kokok Balenggek chicken was ii e+ _bbssld_pp.

Table 1: Percentage of external genetic characteristic of kokok balenggek chicken in west Sumatra

External character	Locus	Genotype (phenotype)	Total sample (head)	Percentage of phenotype
Feather color	I_i	I-(white)	7	03.45
		li (coloured)	196	96.55
Plumage color	E_e+_e	E-(black)	30	14.78
		e+-(wild type)	134	66.01
		ee (columbian)	39	19.21
		B-(Strip)	81	39.90
Feather pattern	B_b	Bb (plain)	122	60.10
		S-(silver)	58	28.57
Feather flick	S_s	ss (gold)	145	71.43
		Id-(yellow/white)	140	68.96
Shank color	Id_id	idid (black/grey)	63	31.04
		P-(pea)	2	00.99
Comb type	Id_id	pp (single)	201	99.01

Table 2: Gene frequency of external genetic characteristic of kokok balenggek chicken in west Sumatra

External Character	Locus	Phenotype	Genotype	Gene	Gene frequency
Feather Color	I _i	White	I-	ql	0.0174
		Colored	ii	qi	0.9826
Plumage color	E _{e+} _e	Black	E-	qE	0.0334
		Wild type	e+	qe+	0.5283
		Columbian	ee	qe	0.4383
Feather pattern	B _b	Strip	B-	qZB	0.2570
		Plain	bb	qZb	0.7430
Feather flick	S _s	Silver	S-	qZS	0.1959
		Gold	ss	qZs	0.8041
Shank color	Id _{id}	yellow/white	Id-	qZId	0.5470
		black/grey	idid	qZid	0.4530
Comb type	P _{pp}	Single	pp	pp	0.9951
		Peas	P-	P-	0.0149

ql = white, qi = colored-plumage, qZB = strip
 qZb = plain, qZS = silver, qZs = golden
 qE = black, qe+ = wild, qe = columbian
 qP = pea, qp = single
 qZId = yellow/ white, qZid = black/green

Table 3: Level of influence value (rate of introgression) from Europe and American chicken White Leghorn (WL), Rhode Island Red (RIR), Bared Plymouth Rock (BR) on Kokok Balenggek chicken in West Sumatra

Introgression	Rate of introgression
Q _{SR}	0.2900
Q _{WL}	0.0174
Q _{BR}	0.2396
Q _{SR} +Q _{WL} +Q _{BR}	0.5470
Purity gene	0.4530
1-(Q _{SR} +Q _{WL} +Q _{BR})	45.30%

Q_{SR} = frequency of RIR Q_{WL} = frequency of WL Q_{BR} = frequency of BR

Level of influence value (rate of introgression) from Europe an American chicken: The outcome of the research showed that the introgression rates from exotic breed with value 0.5470 derived from Rhode Island Red (Q_{SR}) for 0,2900, Bared Plymouth Rock (Q_{BR}) for 0,2396 and White leghorn (Q_{WL}) 0.0174. Thus Kokok Balenggek chicken has 0.4530 of the purity gene. The rate of introgression exotic breed to Kokok Balenggek chicken is presented on Table 3.

Purity gene of Kokok balenggek chicken: The calculation of the purity rate of Kokok Balenggek chicken is presented in Table 4. The purity gene frequencies of Kokok Balenggek chickens have a high value for the gene e+ (wild type pattern), e (columbian feather pattern), Zs (flickering golden fleece), Zid (shank color black/gray) and p (single comb shape).

Genetic variability of Kokok balenggek chicken: The calculation of heterozygosity value Kokok Balenggek chickens can be seen in Table 5. Kokok Balenggek chickens have relatively uniform on comb shape and color of feather, these indicated by the percentage of heterozygosity of 0.0901 and 0.0342. Kokok

Table 4: Frequency of the purity gene of kokok balenggek chicken

Gene Frequency of purity gene	Rate of purity gene frequency
q _E ^(h) = q _E -q _B	-0.2236
q _e ^(h) = q _e *	0.5283
q _e ^(h) = q _e -Q _{SR}	0.1483
q _S ^(h) = q _S -q _B	-0.6082
q _s ^(h) = q _s -Q _{SR}	0.5141
q _{id} ^(h) = q _{id}	0.4530
q _p ^(h) = q _p -q _{id}	0.4480
q _p ^(h) = q _p	0.0050

q_E = black, q_e+ = wild, q_e = columbian
 q_S = silver, q_s = golden
 q_P = pea, q_p = single
 q_{id} = black/green

Table 5: Expected of Heterozygosity/individual (h) and the average of heterozygosity/individual (H) of kokok balenggek chicken

External genetic characteristic	Heterozygosity (h ± SE)
Feather color	0.0342±0.0125
Plumage color	0.5277±0.0503
Feather pattern	0.3820±0.0211
Feather flick	0.3150±0.0239
Shank color	0.4956±0.0049
Comb type	0.0099±0.0049

Mean Heterozygosity (H±SE) 0,2941±0,0429

Balenggek Chicken has a uniform comb shape that forms a single comb. This is indicated by the value of heterozygosity per individual (h) of 0.0099±0.0049, The highest heterozygosity values founded in feather patterns and shank colour indicated the shank with heterozygosity values 0.5277±0.0503 and 0.4956±0.0049, while the feather pattern and flicker feathers varied. Values to the average heterozygosity per individual is relatively diverse in the amount of 29%.

DISCUSSION

The Kokok Balenggek chicken has color of plumage pattern Pigmentation differences, which are attributable to melanin. Thus, melanin produces a variety of plumage colours in chickens. The presence and level of melanin pigments such as trichochrome determined the feather's colour and it is considered to be indicative of genetic differences among certain colour of plumage colours (Smyth, 1990). The strip base color of feather exist if the distribution of melanin on secondary feather is blocked. The variety of base color of feathers is the sex linked gene that can be found as ZBW and ZBZB or ZBZb, respectively both in male and female (Hutt, 1949). This research related to the research of Nishida *et al.* (1980) and dan Mansjoer (1985) that described the native chicken in Indonesia as closely related to Sumatra red jungle fowl (*Gallus gallus gallus*).

The higher frequency of yellow shank coloured (Id₁) 68.96% to black/green color is in line with the report by Sartika and Iskandar (2007), Sartika *et al.* (2008) who discovered that the white/yellow skin was dominant in the indigenous chickens in Indonesia. The melanin on epidermis determined the black color of chicken shank, whereas the lipochrome on epidermis and melanin on dermis determined green color of chicken shank (Jull, 1951). It has been generally assumed that the red jungle fowl is the sole wild ancestor of the domestic chicken (Crawford, 1990; Fumihito *et al.*, 1994; Romanov and Weigend, 2001; Sulandari and Zein, 2008). However, Eriksson *et al.* (2008). This demonstrates that the white skin allele originates from the red jungle fowl (*Gallus gallus*), the yellow skin allele originates from a different species, most likely the one that closely related to the grey junglefowl (*Gallus sonneratii*).

Genetically, genes that affect plumage color also affect shank color (Crawford, 1990). The common comb type in Kokok Balenggek was single comb (99.01%), limited figures for both pea and rose comb. In this regard, Sartika *et al.* (2008), Kusnadidi and Arlina (2011) reported that the single comb, respectively were the common comb type in the population of native chickens. Crawford (1990) stated that the heredity of comb type in chickens is due to two autosomal pairs of genes (Rose comb, RR and Pea comb, PP), the single comb is due to the recessive type of them (rrpp).

Similar observation by Sartika *et al.* (2008) also discovered that in the Kampung (village), the chickens were colourfull (ii), had wild type pattern (e+), plain feather (ss) and golden flick feather (ss), with yellow shank colour (Id₁) and single comb (pp). The research conducted by Nishida *et al.* (1980) yaitu ii e+e+ bb ss idid PP, whereas in Wareng chickens (I₁ E₁ bb S₁ Id₁ pp) (Sartika *et al.* 2008). The relatively rarity of chicken with black plumage colour can be attributed to the fact that the black chickens (especially cocks) are important

components in traditional belief and therefore, they are widely sought after to be sacrificed. Thus reducing the chance of further breeding

Large variation in plumage colour on the indigenous chicken population is indicative of unconscious selection effort. Ensminger (1992) stated that plumage color and pattern, skin color, shank and comb type are inherited by single pairs of genes that able to influence the preference of the consumers. However, till now there was a very limited data that indicates the variation in plumage colour of the indigenous chickens in Indonesia is mainly due to the lack of conscious selection or breeding programs towards choice of colour.

The appearance of the external characteristics of chickens in Southeast Asia such as Indonesia is influenced by the exotic breed from Europe and America ie; White Leghorn, Rhode Island Red and Plymouth Rock Bared (Nishida *et al.*, 1980). Level of introgression rates of exotic breed to the native chicken determine the level of authenticity also high content of native genes showed a high level of authenticity.

According to Nishida *et al.* (1982) the highest the rate of introgression of exotic breed to Indonesian native chickens came from Rhode Island Red and Plymouth Rock Bared while from White Leghorn is very low. The level of influence value (rate of introgression) from the European and American chicken for Wareng chicken was 84% and to Kampung chicken was 25%. (Sartika *et al.*, 2008). Thus Kokok Balenggek chicken has 0.4530 of the purity gene. These findings are consistent with the observations made by Nishida *et al.* (1982) and Mansjoer (1985) that indicate the native chicken in Indonesia still has the purity genes as much as approximately 50%.

The calculation of the purity rate of Kokok Balenggek chicken is based on gene E (black feather pattern), e+ (wild type pattern), e (columbian feather pattern), ZS (flick silver feathers), Zs (flick golden fleece), Zid (black shank/gray colour), P (pea comb shape) and p (single comb shape) (Nishida *et al.*, 1982). According to Nishida *et al.* (1980) Indonesian native chicken that has feather pattern of the original gene is wild type (e+), flickering gold feather (s). shank color black (id) and pea comb shape (P).

Kokok Balenggek chicken have relatively uniform on comb shape and color of feather, these indicated by the percentage of heterozygosity of 0.0901 and 0.0342. This is in accordance with Javanmard *et al.* (2005) who stated that a population has low gene diversity if it has a value of heterozygosity less than 0.5.

Kokok Balenggek Chicken has a uniform comb shape that forms a single comb. This is indicated by the value of heterozygosity per individual (h) of 0.0099±0.0049, which means that the percentage of diversity of the comb shape was 0.01%. The highest heterozygosity values found in feather patterns and shank colour indicated

the shank with heterozygosity values 0.5277 ± 0.0503 and 0.4956 ± 0.0049 , while the feather pattern and flicker feathers varied. The values to the average heterozygosity per individual is relatively diverse in the amount of 29%. This result is consistent with observations made by Widiastuti (2005), who stated that the rate of heterozygosity rate of Kampung chicken about 26-45%. Sartika *et al.* (2008) stated the variability genetic of Kampung chicken (39%) higher than Wareng chicken (16%). The difference in heterozygosity values that occur in local chickens in Indonesia depends on how far the chicken cross with the European and American chicken as well as the selection made by farmers.

The Constitution of genes that control the external genetic character of Kokok Balenggek chicken is $ii e+ _ bb _ ss _ ld _ pp$. This in line with the report presented by Sartika *et al.* (2008) in village's chicken. The Kokok Balenggek chickens showed heterozygosity in the external genetic characteristic considered. Kokok Balenggek chicken have the purity gene was 45.30% and the average of heterozygosity external genetic characteristic about 29.41%. Therefore, further investigation on the quantitative traits and the molecular analysis need to be done to identify the genetic variability and to complete a set of characterization of the Kokok Balenggek chickens. In addition, it is important to take into account the uniformity of qualitative characters to make local strains are similar in their morphological and productive characteristics.

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