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Estimation of Inbreeding Rate in *Kokok balenggek* Chicken (KBC) Population under Ex-Situ Conservation

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Abstract: A survey was carried out in "Kinantan Bagombak" Breeding Farm (KBBF) in Solok City-Indonesia to estimate inbreeding rate on *Kokok balenggek* chicken (KBC). Estimation of inbreeding rate in a small and limited population of local chickens is very important to prevent inbreeding depression. KBC is a poultry genetic resource known as song fowl from West Sumatera Province, Indonesia. This research was aimed to calculate flock composition, effective population size (N_e) and inbreeding rate (ΔF) in KBC under ex-situ population. Census was the main research method. The results showed that total number of KBC at KBBF was 528 heads. Chicken flock composition of KBC was chick (31.63%), chicken grower (27.65%) and adult chicken (40.72%). Number of breeding males (N_m) was 54 heads and females (N_f) was 161 heads. Male and female ratio (N_m/N_f) was 1:3 (33.54%). Effective population size (N_e) was 162 heads. The rate of inbreeding (ΔF) calculated for the indigenous KBC flock considering the existing flock size and management practice was 0.0031 (0.31%) indicating that the population is not at the risk of extinction. It is concluded that inbreeding depression in KBC population at KBBF was not occurred.

Key words: *Kokok balenggek* chicken, inbreeding rate, effective population size, Solok-Indonesia

INTRODUCTION

Traditional chicken breeds are still highly connected to cultural values, geographical origins and adapted to local environments which result in chicken genetic diversity (Lariviere *et al.*, 2011). Genetic diversity in chickens is needed to avoid inbreeding in the chicken population. Awareness of the need to conserve such resources has led to initiate an integrated strategy for conserving chicken genetic resources (Lariviere and Leroy, 2007). Nevertheless, many of them have undergone a major decrease in their population size, requiring genetic management of their resources to monitor inbreeding rate, an important aspect of conservation programs. Inbreeding in poultry affects fertility, hatchability, embryonic viability and egg production, reducing number of progeny hatched per hen, thus decreasing reproductive efficiency and increasing costs in conservation efforts.

Population size has a major impact on the dynamics of a population, the smaller the population the higher the tendency to be depressed in its reproductive potentials due to inbreeding (Klemetsdal, 1998; Thompson *et al.*, 2000). The inbreeding depression in reproductive and productive traits has been reported by Flock *et al.* (1991) and Smith *et al.* (1998).

KBC, known as a song fowl for Minang Kabau people, is a genetic resource from West Sumatra Province, Indonesia, as can be seen in Fig. 1-2 (Rusfidra, 2004; Rusfidra *et al.*, 2012; Rusfidra *et al.*, 2014; Fumihito *et*

al., 1996). KBC is also one of the national genetic resources in Indonesia (Ministry of Agriculture, 2011) (Fig. 1-2). This study was conducted to calculate inbreeding rates in KBC breed populations. It was rated by number of breeding males and females conserved by KBBF in Solok City-Indonesia.

MATERIALS AND METHODS

Population of KBC breeds: Data was collected from an observational survey at KBBF in Solok City, West Sumatera Province, Indonesia. The KBBF had 20 members of breeder and this study surveyed the number of breeding males (N_m) and females (N_f) belonged to the breeders.

Effective population size: The effective population size (N_e) is the number of individuals from a population randomly selected and randomly mated that would expect to have the same rate of inbreeding as the population itself. N_e per breeding population was estimated which consequently enabled the researcher to estimate the rate of inbreeding using the equation by Wright (1931); Falconer and Mackay (1996):

$$N_e = \frac{(4.N_m.N_f)}{N_m + N_f}$$

where:

N_e : Effective population size

N_f : Number of breeding females in breeding population

Nm: Nm is the number of breeding males in breeding population

Effective population size over total population size and male-female ratios: The ratio of the effective population size to actual population size (N_e/N_a) is an indicator of the extent of genetic variation expected in a population. Male:female ratio (N_m/N_f) is defined as the number of breeding males upon the number of breeding females in a population available during the study period (Lariviere *et al.*, 2011).

Inbreeding rates within populations: Rate of inbreeding (ΔF) of KBC was therefore estimated according to the formula by Wright (1931) and Falconer and Mackay (1996):

$$\Delta F = \frac{1}{2N_e}$$



Fig. 1: KBC was singing



Fig. 2: KBC singing contest in West Sumatera Province, 2013 (Doc. Sunardi)

RESULTS AND DISCUSSION

Effective population size and male-female ratio: Flock structure and dynamics help in the identification of

the age and number of animals to be maintained within the breeding population (Okeno *et al.*, 2012). Estimated N_e , N_e/N_a and N_m/N_f are given in Table 1. The N_e/N_a and N_m/N_f ratio on KBC were 75.35 and 33.54%, respectively. This finding was within the range of that found by Lariviere *et al.* (2011), in which the N_e/N_a and N_m/N_f ratios of 40 traditional Belgian chicken were varied from 57-89% and from 23-51%, respectively. Similar results were found when compared to the N_e/N_a and N_m/N_f ratios in some European chicken populations, which were varied from 33-82% and from 8-25%, respectively (Spalona *et al.*, 2007). Meuwissen and Wooliams (1994) suggested that N_e between 30 and 250 was needed for natural selection to counteract inbreeding depression. N_e is a measure of genetic variability within a population where large values of N_e indicate more variability and small values reveal less genetic variability (Maiwashe *et al.*, 2006; Cervantes *et al.*, 2008).

The male:female ratio (N_m/N_f) was calculated based on the number of breeding males and females available during the study period. N_m/N_f ratio in KBBF was 1:3. The recommended male:female ratios were 1:8 - 1:10 for mating. The males were underutilized therefore the increase of female chicken needed to ensure proper utilization of male (Hagan *et al.*, 2013). The proportion of mature hens in a flock can be used to estimate egg and poultry production (Yakubu, 2010). The low sex ratio on the studied farms was an indication that the breeding system was not controlled by the farmer (Zahraddeen *et al.*, 2011).

Inbreeding rates within population: Estimate of inbreeding rates (ΔF) is also presented in Table 1. The rate of inbreeding (ΔF) calculated for the indigenous KBC flock considering the existing flock size was 0.0031 (0.31%). Inbreeding is the probability that two alleles at any locus in an individual are identical by descent relative to a base population (Falconer and Mackay 1996). The ΔF less than 1% means that 1% of heterozygosity is lost in one generation. The low value of ΔF in the study was an indication that the KBC population was not at the risk of extinction because ΔF was less than 1%. In Belgian chicken breeds, only populations with N_e of less than 50 showed ΔF over 1% per generation. Estimates in populations with N_e of more than 50 would give inbreeding rate (ΔF) within the range of 0.03-0.94% as what has been found on small chicken flocks in Europe (Lariviere *et al.*, 2011). Moreover, a study on population size of 37 local chicken breeds conserved in institutions of five European countries demonstrated relatively low ΔF (0.02-0.71%) (Spalona *et al.*, 2007).

Table 1: Number of breeding males (Nm) and females (Nf), male:female ratio (Nm/Nf), total breeding population (N), effective population sizes (Ne), Ne/N ratio of breeders contributing efficiently genes to the population and hypothetical rates of inbreeding per generation (ΔF) of KBC in West Sumatera Province-Indonesia

Breed	Nm (head)	Nf (head)	Nm/Nf (%)	Na (head)	Ne (head)	Ne/Na (%)	ΔF (%)
<i>Kokok balenggek</i> chicken	54	161	33.54	215	162	75.35	0.31

Conclusions: The results showed that flock composition of KBC was chick (31.63%), chicken grower (27.65%) and adult chicken (40.72%). Number of breeding males (Nm) was 54 heads, and number of breeding females (Nf) was 161 heads. Male and female ratio (Nm/Nf) was 33.54% (1:3). Effective population size (Ne) in associated population was 162 heads. The inbreeding rate of KBC was 0.31%. The low rate of inbreeding in the KBC flock was an indication that the population was not at the risk of extinction. A rapid strategy to minimize inbreeding would be to maximize the effective population size in flock and increase the male:female ratio in KBC population.

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