Crossbred Local Chickens from East Nusa Tenggara Province Indonesia Under Semi Intensive Management System

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Abstract. The objective of this study was to compare the performance of four-breed combination of local chickens under semi intensive management system. The experiment used 160 females and 40 males chickens as parents. Artificial insemination was performed to produce the experimental chicken of the four breed combinations (1. Sabu x Sabu, 2. Sabu x Semau, 3. Sabu x KUB, 4. Semau x KUB). The chickens were fed with chick starter crumbs ad libitum from day old to 4 weeks of age. From 4-8 weeks of age, chickens were allowed to scavenge during the day, and also given commercial grower pellets + rice bran + corn (5:4:1). Combination of Sabu x KUB from 4-8 weeks of age were significantly heavier (P<0.05) than the other combination breeds. Feed intake in the Sabu x KUB group was the lowest, and their weight gain was the highest among the others group (P<0.05). The combination Sabu x KUB also had the highest egg production, and hatchability. However, the percentage of abdominal fat of Sabu x KUB were higher than others groups. In conclusion, combination Sabu x KUB had the best growth performance and egg production performance, but not for the percentage of abdominal fat.

Keywords: Local chicken, Crossbreeding, Semi intensive, Management system

1. Introduction

Local chickens have been raised by most of the rural people of East Nusa Tenggara Province (NTT) Indonesia, and they represent an important source of meat and eggs. Population of local chicken in NTT counted 19.3% to the total chicken population in NTT province[1]. Some local chickens in NTT Indonesia are well-adapted to local environmental conditions but exhibit slow growth rate, other local chickens are not well-adapted to local environmental conditions but exhibit rapid growth rate and high egg production. Though some local chickens are slow grower and poor layers of small sized eggs they are, however, ideal mothers and good sitter, excellent forages, and hardy [2], and possess natural immunity against common diseases [3]. Hardiness is ability to tolerate the harsh environmental condition and poor husbandry practices (climate, handling, watering and feeding without much loss in production [3,4]. Sabu (Sb) and Semau (Sm) chickens are some local chicken that are spread widely in East Nusa Tenggara – Indonesia. Sabu chickens can produce higher body weight than other native chicken in NTT, and Semau chickens have better disease resistance[5]. There were also KUB chickens which produced by Indonesian Agency for Agricultural Research and Development. KUB chickens are a superior chicken in high egg production[6].
Genetic improvements in the tropics on native indigenous chicken genetic resources are either rare or non-existent [2]. Genetic improvement can be achieved through cross breeding with or without genetic selection in the parent lines, through up grading by repeated back crossing to a superior parent breed[7]. Breeding program targeting improvement focus on within breed selection rather than crossbreeding with commercial chicken breeds to maintain the indigenous chicken unique attributes which are appreciated by producers and avoid genetic erosion and dilution and contribute to their conservation[8]. Instead in most instances developing countries uses high yielding commercial lines developed for intensified management system for crossbreeding with native fowl to increase the egg and meat production[8–10]. Some countries has well developed breeds through long term crossbreeding and selection using local chicken population as foundation stocks[2]. In this study, genetic improvement of local chicken focused on crossbreeding to maintain indigenous chickens in NTT province Indonesia. Crossbreeding can be used as a strategy to improve growth performance of local chickens in East Nusa Tenggara Province Indonesia.

In terms of rearing management system, most farmers in East Nusa Tenggara Province (NTT) raised local chickens in traditional system. The local chickens were provided with limited facilities such as a simple cage, a small amount of food scraps, and no diseases prevention program[1]. The typical flock size were small, there were no equipped for chicken genetic improvement. Cross breeding methods is good approach at farm level for small flock size under semi intensive management system, poor infrastructure and similar trait interest[11]. Egg production per hen, meat yield and diseases resistance were the farmers preferred trait to be improved in East Nusa Tenggara province Indonesia. Okeno et al. [8] reported that utilization of native chicken in their current genetic merit and production environment is more profitable under free range system and semi intensive system but not economically viable under intensive system. Semi intensive chickens rearing system is one of the methods in reducing various problems and improving performance and production of chicken village in NTT-Indonesia. The objective of this study was to compare the performance of local breed combination under semi intensive management system.

2. Materials and Methods

2.1. Ethics statement

All experiments were performed in accordance with the approved guidelines. The experiment was conducted at the integrated dry land areas at campus of Nusa Cendana University Kupang. The bird handling procedures met the requirement set by the Institutional Animal Care.

2.2. Parent stock and experimental chicken

Breeding program used 160 females and 40 males chickens as parents, ratio males : females = 1 : 4. Artificial insemination was performed to produce the experimental chicken of the four breed combinations as shown in table 1.

| Breed combination     | Number of pullet | Total |
|-----------------------|------------------|-------|
|                      | Hatch 1 | Hatch 1 | Hatch 3 | Hatch 4 |       |
| Sabu x Sabu           | 9       | 12      | 11      | 12      | 44    |
| Sabu x Semau          | 8       | 9       | 10      | 10      | 37    |
| Sabu x KUB            | 10      | 12      | 14      | 15      | 51    |
| Semau x KUB           | 9       | 13      | 15      | 15      | 52    |
|                       |         |         |         |         | 184   |

Eggs were hatched in four batches with intervals of eleven weeks. Eggs were collected and incubated in automatic incubator at 37°C and 65% RH for 21 days to produce cross bred. After
hatching, chicks were housed in brooder cage up to 4 weeks. Then, from 4-6 weeks of age, the chickens were housed in grower cage.

2.3. Pullet rearing
There were about 184 pullets from 4 breed combination. The chicken were kept until they were about one years old or had produced eggs for almost one year, they were kept in a cage at night. The birds were housed in a bamboo shelter when offered feed. During the day, chickens were reared in an open sided poultry shed with access to a grass paddock. There was a continuous supply of drinking water in the cage. De-worming was done every two months. Vaccination against Newcastle and Fowl Pox diseases was according to a set program. Data regarding egg production mortality and supplementary feed were recorded.

The birds were allowed to scavenge during the day, and they were given supplementary food starter crumbs from day old to 4 weeks of age. From 4 - 8 weeks of age, chickens were given commercial grower pellets + rice bran + corn (5:4:1), and water was provided *ad libitum*. All diets were optimized to the same ME level and to the same nutrient content. The selection and allocation procedure was such that the mean group weights were the same and contained a similar range of body weights; birds with extreme low or high body weight were discarded as were sick birds. Birds were monitored several times each day for the duration of experiments.

2.4. Measurement
Average daily gain was measured between ages 4 and 8 weeks. Feed intake and feed conversion ratio also were measured between ages 4 and 8 weeks. Each week, birds were individually weighed, feed intake per pen was measured, and feed conversion ratio (FCR) was calculated. Carcass yield, mortality rate, egg production, hatchability and egg weight were also obtained. Mortality was recorded daily and the weight of dead birds was recorded.

At 8 weeks of age, two birds with mean weights close to the mean body weight in the pen were euthanized by an intra cardial injection of sodium pentobarbitone solution and individually weighed. The breast meat (*Pectoralis major* and *Pectoralis minor*) was removed by cutting laterally at the wing joint and dissecting the muscles from the carcass. The abdominal fat, which included the fat surrounding the gizzard extending within the ischium and surrounding the bursa of fabricius, cloaca, and adjacent abdominal muscles, was removed and weighed. The yield of breast meat and abdominal fat were expressed as proportions of live weight.

2.5. Statistical Method
The effects were simultaneously analyzed by use of an analysis of variance using the GLM procedure and then tested by the F-test. The significant level was set at P<0.001 by Duncan’ s multiple range test. If the F-ratio indicated significance, the differences between the means were separated using the Least Significant Difference test.

3. Result and Discussion
There were significant differences (P<0.05) in growth performance of four combination breed (Table 2). This probably because of there is no genetic similarities between the crossbreed local chicken (heterosis effects) and the breakdown of gene combinations in the F cross during gametogenesis[12].

| Parameter | SbxBs | SbxBm | SbxBKUB | SmbxKUB | Pooled | P-value |
|-----------|-------|-------|---------|---------|--------|---------|
| Weight gain (g/b/d) | | | | | | |
| 4-5 weeks | 62.8 b | 56.5 a | 57.7 a | 55.6 a | 2.22 | <0.0001 |
| 5-6 weeks | 62.7 c | 75.7 ab | 78.6 ab | 84.7 a | 3.34 | <0.0001 |
Table 2 shows the average body weight gain were markedly different (P<0.001) among four breed combination. Combination of Sabu x KUB were significantly heavier (P<0.05) than the other combination breed. This might be attributed to the differences in hormonal profile, aggressiveness and dominance of Sabu chickens[1]. The previous studies[13,14] demonstrated that weight gain increased with crossing bred chickens which are in agreement with the results of the current study. Local breeds have been shown to possess both superior level of genetic variation relative to commercial breeds and unique phenotypic traits signifying valuable local adaptations[14,15]. The difference in weight gain among the genotypes were observed from 4 to 8 weeks of age. As[10]stated that weight gain was observed from an earlier age. Therefore, age affect growth performance may vary depending on breeds or crossbreeding.

3.2. Feed intake
Feed intake in the Sb x KUB group was the lowest, and their weight gain was the highest among the thers group (Fig.1). The results of these experiments suggest that somewhat Sb x KUB had a greater efficiency of food utilization. This study suggesting that polymorphism improves the growth rate, and this phenomenon is not limited to purebred and crossbred chickens[10]. KUB chickens were imported from Java island West Java province Indonesia 2-3 years ago[6,16]. So, the purity of such imported breeds is undoubtful. However, continuous inbreeding may now have caused them to be less productive[12]. In developing countries, crossbreds from indigenous and exotic chickens perform better under semi intensive management system, because of their combining ability and genetic make-up[8,13].

|                | 6-7 weeks | 7-8 weeks | 4-5 weeks | 5-6 weeks | 6-7 weeks | 7-8 weeks |
|----------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Feed intake (g/d) |           |           |           |           |           |           |
| 4-5 weeks       | 106.2 b   | 107.3 a   | 106.1 a   | 103.9 a   | 2.80      | <0.0001   |
| 5-6 weeks       | 169.7 b   | 172.7 a   | 163.1 a   | 170.3 a   | 4.85      | <0.0001   |
| 6-7 weeks       | 180.8 b   | 204.0 a   | 197.0 a   | 197.8 a   | 8.41      | <0.0001   |
| 7-8 weeks       | 152.3 b   | 161.3 a   | 145.3 a   | 147.8 a   | 3.95      | <0.0001   |
| FCR             |           |           |           |           |           |           |
| 4-5 weeks       | 1.69 b    | 1.90 a    | 1.87 a    | 1.87 a    | 0.21      | 0.05      |
| 5-6 weeks       | 2.71 b    | 2.30 a    | 2.08 a    | 2.01 a    | 0.17      | 0.01      |
| 6-7 weeks       | 2.71 b    | 2.57 a    | 2.41 a    | 2.58 a    | 0.01      | 0.01      |
| 7-8 weeks       | 2.26      | 2.29      | 1.76      | 2.09      | 0.89      | 0.01      |
| Meat yield:     |           |           |           |           |           |           |
| Breast muscle (%) | 10.9 a   | 12.7 a    | 15.9 b    | 11.9 a    | 1.40      | 0.000     |
| Abdominal fat (%) | 0.90     | 1.31      | 1.79      | 2.19      | 0.68      | 0.067     |

Values in the same row with different superscripts are significantly difference (P<0.05)
Crossing Sb x Sm was not effective in improved weight gain, they eat more, but their weight gain was less than Sb x KUB crossbred chickens. High temperature during the study may have caused slow growth of young birds, and might be associated with low feed intake during dry period. This finding as was stated by [1] indicating the common characteristics of chicken performance in the village in NTT province Indonesia. During rainy season, limits free scavenging activities of birds, the amount of supplementary feed was likely to have a profound effect on body weight of chicken. Supplementary feed were provided two times a day (morning and evening). Local chickens get their feed by scavenging for insects and wasted grains scattered in the farm, green vegetation with supplementary feed.

3.3. Carcass yield
The percentage of breast muscle of Sb x KUB chicken was significantly (P<0.05) higher than the other breed combination (Fig.2). The lowest percentage of breast muscle was Sb x Sb crossbred chicken. Abdominal fat was not difference (P>0.05) among four breed combinations. Providing supplementary feeding with scavenging production system can meat yield. Small scale under semi intensive management system require dual purpose that produce eggs and meat. KUB chicken were renowned as good layers and mothers, thus suitable candidate breeds in crossbreeding program. Sm x KUB under semi intensive management system in tropical climate may be worthy combinations for improving meat production.
Table 3 show egg production performance of crossbred chicken under semi intensive management system. There were significant differences (P<0.05) in egg production performance of four combination breed.

| Parameter                              | SbxSb | SbxSm | SbxKUB | SmxKUB | Pooled SEM | P-value |
|----------------------------------------|-------|-------|--------|--------|------------|---------|
| Age of first egg (week)                | 28\(^b\) | 28\(^b\) | 24\(^b\) |        | 24\(^a\) | 2.23    | <0.05   |
| Egg production/hen/Year                | 154\(^a\) | 157\(^a\) | 160\(^b\) |        | 155\(^a\) | 4.25    | <0.0001 |
| Period of egg production/year          | 8\(^a\)      | 8\(^a\)      | 8\(^a\)      |        | 8\(^a\)      | 2.95    | <0.0001 |
| Egg weight (g)                         | 38.9     | 38.1     | 40.1     |        | 42.0     | 3.05    | 0.08    |
| Hatchability on fertile eggs (%)       | 60.5\(^a\) | 59.8\(^a\) | 71.8\(^b\) |        | 69.2\(^b\) | 2.05    | <0.05   |
| Mortality (%)                          | 5\(^a\)     | 3\(^a\)     | 8\(^b\)     |        | 5\(^a\)     | 2.95    | <0.0001 |

3.4. Age at first egg laying
The overall mean of age at first egg laying for hen in this study was 24-28 weeks. There was significant difference (P<0.005) in means of age at first egg laying. Sb x KUB and Sm x KB lay egg the first time at 24 weeks of age, whereas Sb x Sb and Sb x Sm lay first egg at 28 weeks of age. This result comparable with the findings of[5]who reported that the mean age at first egg laying of local chickens in NTT Indonesia was 24-28 weeks. This results is higher than from mean age at first egg laying of chicken found in other region of NTT which were 30-32 weeks reported by[1]. One possible genetic mechanism to counteract the declines of fitness traits with age is heterosis. The heterosis for egg production reported in literature is highly variable, as depends on the nature and degree of genetic differences among strains[17].
3.5. Egg production
Egg production had significant difference (P>0.05) among four crossbred combination. Sabu x KUB had the best performance with the highest egg production. The others breed combination had no any significance difference (P>0.05). The combination Semau x KUB with the highest genetic potential for egg production did not express this genetic potential in this study. Recent study indicated that egg production in smallholder could be double in the existing production system through intervention of crossbreeding under semi intensive management system.

3.6. Egg weight
Egg weight of four crossbred combination did not have any significant difference. The mean egg weight in the present study was consistent to values reported by others[1,13]. The higher egg weight in Sm x KUB than other crossbred could be attributed to its genetic potential for the production of large sized eggs. In addition, KUB is a well established breed and selection for better egg size. There is positive correlation between egg weight and hatching weight. Egg with heavier weight were hatched to heavier chicks[8].

3.7. Hatchability
KUB x Sm show better hatchability than other breed combinations. Sm x KUB under semi intensive management system in East Nusa Tenggara province Indonesia may be the most suitable combinations to have improved hatchability. Hatchability is affected by egg shell quality, with the hatchability of thin shelled eggs being 3-9% lower than the thicker shelled eggs[8,18]. Thin egg shells result in reduced hatchability and weakening of the embryo.

3.8. Mortality
There was susceptibility difference in different groups of breed combination. Mortality rate of cross breed Sabu x Semau significantly lower than mortality rate of the others breed combinations. Semau chicken had better disease resistance than Sabu and KUB chicken. Sabu x KUB combination had the highest rate of mortality. Cannibalism was observed as a constraint in dry and sun drenched season that almost occur in NTT. Also, Newcastle disease (ND) was the most prevalent disease affecting local chicken production. This result shows an agreement with the reports of that ND and cannibalism are the major cause of local chicken death in NTT province-Indonesia. All local chicken were not equally susceptible for diseases. Improving management system (supplemental feeding and vaccination) result in improved performance, and improved survival rate of young birds. NTT province – Indonesia is characterised by its dry-climate with harsh environment, so that tolerance to high temperature is a key requisite in the birds.

4. Conclusion
The combination Sabu x KUB had the best performance with the highest egg production, and hatchability. Also, crossing Sabu x KUB appeared to be adequate to support good growth from 4-8 weeks of age and may reflect the faster growth rate and better feed efficiency. However, the percentage of abdominal fat of Sabu x KUB and Semau x KUB were higher than Sabu x Sabu chickens.

Acknowledgment
The authors wish to thank the RISTEKDIKTI DRPM for financially supporting this project (Project no. 007/SP2H/PPM/DRPM/2018).
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