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RESEARCH ARTICLE
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# Effect of Assortative Mating on the Production Performance and Growth of Kokok Balenggek Chickens

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## ABSTRACT

This study aims to characterize the phenotypic traits of the first generation (G1) of the Kokok Balenggek Chicken (KBC), which was designed through assortative mating. A total of 56 KBCs (8 males, 48 females) were used in four breeding schemes (BS-1 to BS-4) with a 1:6 mating ratio. Chickens were housed in a pen for mating. The observed variables included hatch and hatch egg weight, feather color, beak color, shank color, and growth for 10 weeks. The acquired data, such as mean, standard deviation, and coefficient of variation, were examined descriptively. The research findings indicate that the hatch weights were as follows: BS-1 (24.75g), BS-2 (23.50g), BS-3 (25.00g), and BS-4 (24.00g). Feather color dominance varied: BS-1 (white, 77.78%), BS-2 (black, 100%), BS-3 (striped, 27.27%), and BS-4 (striped). Beak colors were predominantly yellow in BS-1 (97.22%), black in BS-2 (87.50%), and yellow in BS-3 (72.73%) and BS-4. Shank colors followed a similar pattern: yellow in BS-1 (97.22%), yellowish black in BS-2 (50%), and yellow in BS-3 (72.73%) and BS-4. Chick growth was uniform across all breeding schemes, showing an upward trajectory from 4 to 10 weeks. The findings suggest that assortative mating can contribute to developing a new KBC breed.

**Keywords:** KBC, Assortative mating, First generation, West Sumatra

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## INTRODUCTION

KBC is a native chicken breed from West Sumatra, recognized as a national poultry breed (Rusfidra et al., 2015; Rusfidra & Arlina, 2015). Male KBC has a unique vocalization and a crowing that varies from 3 to 14 crows. Some can produce up to 19 crows or 22 syllables (Rusfidra et al., 2014a, b). KBC is believed to have originated from the hybridization of the Red Junglefowl (*Gallus gallus*) with indigenous chickens. KBC represents a repository of the genetic diversity of indigenous livestock in Indonesia that requires conservation. Utoyo et al. (1996) classified KBC as being in a troubling condition (threatened species). The quantity of KBC in situ regions is comparatively limited and highly susceptible to extinction. Consequently, initiatives must be undertaken to enhance the KBC population as a significant poultry genetic resource in West Sumatra Province, which possesses considerable economic value for the community.

Various researchers have conducted extensive studies on KBC, encompassing investigations into the characteristics of crowing sounds (Arlina et al., 2020), phenotypic variation in KBC at Randah Batu (Arlina et al., 2024a), the selection effort for Lenggek crowing, and assessments of KBC semen and fertility (Ananda et al., 2024b). At the same time, other studies focused on the viability of KBC as meat chickens, as well as qualitative and quantitative markers of KBC base generation (G0) (Husmaini et al., 2023), reproductive dynamics of KBC post-artificial insemination (Jaswandi et al., 2023) and egg incubation studies (Husmaini et al., 2024). Other studies on the population structure of KBC in in-situ areas (Husmaini et al., 2021), the crowing characteristics of native singing chickens in Indonesia (Bugiwati et al., 2020) and long-crowing chickens in Indonesia (Asmara et al., 2023) have also been carried out.

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Assortative mating pairs two chicken types that exhibit analogous phenotypes, leading to homozygous traits. Assortative mating has a significant influence on speciation by facilitating the initial isolation of phenotypically distinct groups (Kirkpatrick, 2000). Jian et al. (2025) stated that coloration plays a crucial role in sexual selection. These colorations did not correlate with their body condition. The mate choice experiments found that green females preferred green males, while brown females preferred brown males on grass lizards.

KBC can enhance genetic quality and facilitate livestock breeding. Assortative mating is advantageous for the future conservation and integrity of KBC genetic resources. Therefore, this study investigates the impact of assortative mating patterns on KBC's performance and growth characteristics.

## MATERIALS & METHODS

### Ethical Statement

Animal experiments were conducted by Republic of Indonesia Law No. 18 of 2009 (section 66) and Republic of Indonesia Law No. 41 of 2014, which govern animal keeping, raising, and proper treatment and care.

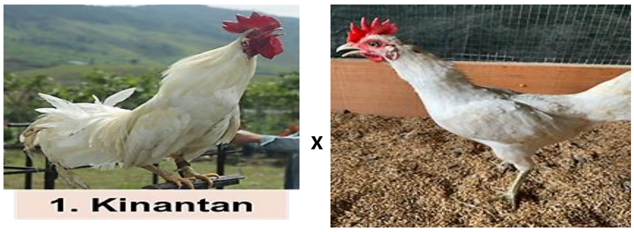
This study was performed in the KBC breeding cage at the Technical Service Unit of the Faculty of Animal Science, Universitas Andalas. This study utilized 8 males and 48 females. The male KBC comprised 2 heads of *Kinantan*, 1 head of *Taduang*, 2 heads of *Jalak,* and 3 heads of *Biriang*. The female KBC comprised 12 white females, 9 Black females, 8 Jalak females, and 19 Lurik females. KBC were housed in a pen measuring 2×1.5×2m, with a ratio of 1 male to 6 female KBC. The mating design is an assortative pattern, as illustrated in Fig. 1.

### Implementation of Research

Assortative mating in this study refers to mating where male and female chickens have the same feather color. Egg production data were observed daily, and the hatching eggs produced were marked according to the breeding pattern of the eggs. The eggs were then collected and stored for a maximum of one week. The hatching eggs, which had been collected over one week, were placed in the incubator. Candling of the eggs was performed twice: on the 3rd day after the eggs were placed in the incubator and again on the 18th day. After hatching, the chicks with dried feathers were weighed to obtain the hatch weight. Then, the chicks' feather, beak, and shank colors were observed, and their body weight was measured weekly until they were 10 weeks old.

### Observed Variables

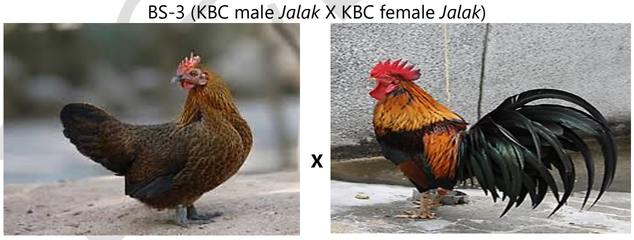
The weight of the hatching eggs was measured on the day the hens laid them. The weight of one-day-old chicks (DOC) was obtained by weighing the chicks that had hatched for 24 hours using a digital scale. Feather color, beak color, shank color, and body weight growth of chickens aged 1-10 weeks were observed. The data analysis employed descriptive statistics, utilizing the formula for relative frequency to calculate the mean, standard deviation, and coefficient of variation.




BS-1 (KBC male *Kinantan* X KBC female white)


BS-2 (KBC male *Taduang* X KBC female Black)


BS-3 (KBC male *Jalak* X KBC female *Jalak*)




BS-4 (KBC male *Biriang* X KBC female *Barred*)

**Fig. 1:** Assortative Mating Breeding Scheme.

## RESULTS & DISCUSSION

Assortative mating is a type of mating conducted based on the phenotypic traits of livestock, such as those with the same feather color (Tuner & Young, 1969). The influence of assortative mating increases the number of homozygous genotypes and reduces the number of heterozygous genotypes in the population. Assortative mating was used in the study, which involved male KBC types consisting of Kinantan, Tadung, Jalak, and Biriang, and female chickens comprising white females, black females, white-black females and Lurik.

### Egg Performance of KBC

The average quality marker of KBC eggs resulting from assortative mating is presented in Table 1. The average egg weight of KBC resulting from the assortative mating pattern over 4 incubation periods is as follows: BS-1 (36.32±2.45g) with a coefficient of variation of 6.75%, BS-2 (39.71±1.26g) with a coefficient of variation of 3.18%, BS-3 (37.54±3.07g) with a coefficient of variation of 8.17%, and BS-4 (36.89±0.68g) with a coefficient of variation of 1.84%. The highest average egg weight was in BS-2, and the lowest was in BS-1.

The average egg index of KBC resulting from the assortative mating pattern is as follows: BS-1 (0.77±0.01) with a coefficient of variation of 1.68%, BS-2 (0.80±0.02) with a coefficient of variation of 2.17%, BS-3 (0.75±0.01) with a coefficient of variation of 1.74%, and BS-4 (0.76±0.01) with a coefficient of variation of 1.71%. The highest average egg index was BS-2, and the lowest was BS-3. Based on the results of this study, the obtained egg index yields less than ideal results, with a higher egg index generally indicating a more rounded egg shape. Yuwanta (2022) stated that the range of egg index values is 0.62-0.82, with an ideal range of 0.70-0.75. The average KBC egg index in this study is not much different from Irawan's (2017) study, where the KBC egg index was 0.78±0.03 with a coefficient of variation of 3.68%.

**Table 1:** Egg Quality Traits of KBC based on Breeding Scheme

| Traits | KBC Kinantan | KBC Tadung | KBC Jalak | KBC Biriang |
|---|---|---|---|---|
| Egg Weight (g) | 36.32±2.45 | 39.71±1.26 | 37.54±3.07 | 36.89±0.68 |
| Egg Index (g) | 0.77±0.01 | 0.80±0.02 | 0.75±0.01 | 0.76±0.01 |
| Fertility (%) | 72.73±3.94 | 59.26±2.55 | 60.61±0.71 | 73.74±4.44 |
| Hatchability (%) | 55.00±2.24 | 50.00±0.71 | 55.00±0.83 | 52.05±2.50 |
| Haching Egg (g) | 24.75±1.09 | 23.50±1.50 | 25.00±1.22 | 24.00±1.22 |

The average fertility of KBC eggs resulting from the assortative mating pattern over 4 hatching periods is as follows: BS-1 (72.73±3.94%) with a coefficient of variation of 5.41%, BS-2 (59.26±2.55%) with a coefficient of variation of 4.30%, BS-3 (60.61±0.71%) with a coefficient of variation of 1.17%, and BS-4 (73.74±4.44%) with a coefficient of variation of 6.02%. The highest average fertility was in BS-4 and the lowest in BS-2. Fertility and hatchability, as primary parameters in production performance, are also influenced by both genetic and environmental factors (Rofii et al., 2018). Several preliminary studies have noted that several minerals, such as sodium, calcium, iron, manganese, zinc, and copper, are vital for embryo development (Wang et al., 2019).

The average hatchability of KBC resulting from the assortative mating pattern over 4 incubation periods is as follows: BS-1 (55.00±2.24%) with a coefficient of variation of 0.04%, BS-2 (50.00±0.71%) with a coefficient of variation of 1.41%, BS-3 (55.00±0.83%) with a coefficient of variation of 1.51% and BS-4 (52.05±2.50%) with a coefficient of variation of 4.80%. The highest hatchability was in BS-1 and the lowest in BS-2. The low egg weight in this study was attributed to issues with the incubator, where the humidity and temperature displayed on the monitor did not accurately reflect the actual conditions, resulting in a low number of fertilized eggs produced. The factors that influence hatchability include the egg's size and quality, including the quality of the shell, the duration of egg storage before incubation, and the operational techniques employed by personnel operating the incubator (Hasanah et al., 2019). Furthermore, according to Ozlu et al. (2021), temperature and humidity affect hatchability because they are related to the embryo. Additionally, hatchability is influenced primarily by egg fertility, incubation conditions (incubator), egg shape, shell cleanliness related to microorganism prevention, and the duration of storage before placement in the incubator. The hatchability of chicken eggs increases and then decreases as the age of the chickens increases. The weight and size of the eggs at the beginning of production are still below normal, so hatchability remains low if they are incubated. The weight and size of the eggs increase until they reach normal weight and size as the chicken ages.

The average hatch weight of KBC from assortative mating over 4 incubation periods is as follows: BS-1 (24.75±1.09%) with a coefficient of variation of 4.40%, BS-2 (23.50±1.50%) with a coefficient of variation of 6.38%, BS-3 (25.00±1.22%) with a coefficient of variation of 4.90% and BS-4 (24.00±1.22%) with a coefficient of variation of 5.10%. The highest average hatch weight was in BS-3, and the lowest was in BS-2. The low hatch weight in this study was attributed to the eggs being smaller than expected at the beginning of production, resulting in a lower hatch weight. According to Sartika et al. (2017), the body weight of KUB-1 chicks is 26 g, per SNI KUB-1 chicken standards.

**Qualitative Traits of Assortative Mating Results in KBC BS-1 Breeding Scheme**

The assortative breeding of BS-1 resulted in yellow feathers (22.22%) and white feathers (77.78%). The white feather color (I) is influenced by the phenotype of the parent, which is white. This statement aligns with Roulin's (2004) assertion that assortative mating in birds with the same feather color tends to produce offspring with the same feather color as their parents. The color of chicken feathers is influenced by the presence of melanoblast pigments formed during the early embryonic stage, approximately 8 hours after incubation (Scanes et al., 2004). In the BS-1 cross, gene I cannot prevent other colors from entering the epidermal layer, resulting in the appearance of colors other than white, specifically yellow, at a rate of 22.22%. Both dominant and recessive genes genetically determine the color of feathers. The greater the chance that additive or dominant genes are inherited through heterozygous individuals and expressed through better phenotypes.

The beak color of BS-1 offspring is yellow (97.22%) and white (2.78%). The dominant trait of yellow or white beak color (Id) is influenced by melanin in the epidermal skin layer. The white or yellow beak color (Id) is due to the low melanin content in the epidermal layer (Hutt, 1949). The function of the Id gene is to inhibit the deposition of melanin in the dermis layer of the skin, resulting in a deficiency of melanin and causing the skin to appear yellow or white. In contrast, the gene that carries the trait for melanin deposition in the dermis layer is the recessive Id gene, regardless of whether it is in homozygous or heterozygous conditions.

The color of the BS-1 shank is yellow (97.22%) and white (2.78%). The Id gene influences the dominant yellow trait, which can regulate melanin in the dermis layer and suppress the formation of colors other than yellow. The white shank color is caused by a lack of melanin in the dermis layer, resulting in an albino condition. Sartika et al. (2008) state that the characteristic yellow/white shank color (Id-) is caused by a lack of melanin content in the skin tissue. The melanin content in the skin layer (dermis) is controlled by a sex-linked recessive gene (id) in either a homozygous or heterozygous state. The black shank color Id (Inhibitor of dermal melanin) is incompletely dominant over Id.

**BS-2 Breeding Scheme**

Assortative mating in BS-2 results in chicks with feather colors identical to those of their parents, specifically 100% black feather color. Assortative mating can be measured as the correlation between homologous phenotypic values or the genotypic traits of all members of the mating pair. The color of the BS-2 beak is black (87.50%) and gray (12.50%). The black color (id) is caused by the white skin color (Id), which is influenced by the presence of melanin in the epidermal layer of the skin. Suprijatna (2008) stated that the village chicken's beak color can be white, black, or a combination of these colors. The shank color of BS-2 is gray (12.50%), black (37.50%), and blackish yellow (50.00%). The combination of blackish-yellow shank color is due to the combination of the (Id) and (id) genes in the skin layer.

**BS-3 Breeding Scheme**

Assortative breeding in BS-3 results in feather colors in chickens being striped (27.27%), brown (18.18%) and blackish white (54.55%). The high percentage of black and white feather color is influenced by the mother's feather color, which is predominantly black and white. According to Crawford (1990), the color of chicken feathers is influenced by the presence of melanin pigments. Melanin pigments are divided into two types: eumelanin, which forms black and blue colors in feathers, and pheomelanin, which forms red-brown, salmon, and yellowish colors. The action of melanin pigments is regulated by the Igene (Inhibitor) gene, which inhibits melanin production, and the (i)gene, which triggers melanin production, resulting in two main traits in chicken feather color: colored and non-colored traits. The feather color in chickens carrying the Igene (the gene carrying the color trait) is not always black.

The color of the BS-3 beak is yellow (72.73%) and white (27.27%). The dominant trait of yellow/white color (Id) is influenced by the presence of melanin in the epidermal skin layer. The white/yellow skin color (Id) is primarily due to the low melanin content in the epidermal layer, which is caused by the action of another gene that has a rejection effect (Hutt, 1949). The gene (Id) inhibits the deposition of melanin in the dermis layer of the skin, resulting in a deficiency of melanin and a yellow or white color. In contrast, the gene that carries the trait for melanin deposition in the dermis layer is recessive (id), which can be in homozygous or heterozygous conditions. The color of the shank in BS-3 offspring is yellow (72.73%) and white (27.27%). Sartika et al. (2008) state that the yellow/white shank color (Id) is caused by a lack of melanin content in the dermis and the skin tissue. The melanin content in the skin layer (dermis) is controlled by the sex-linked recessive gene (id) in either homozygous or heterozygous conditions. The black shank color Id (Inhibitor of dermal melanin) is incompletely dominant over (id).

**BS-4 Breeding Scheme**

The chicks resulting from the BS-4 breeding show that the feather colors are striped (92.11%) and brown (7.89%). The striped feather color is inherited from the female parent's feather color. Roulin (2004) stated that assortative mating in birds produces feather colors similar to those of the parents. The presence of colors other than stripes in the BS-4 breeding is due to the influence of eumelanin pigments, which form a brown color in the feathers. The beak color of BS-4 offspring is all yellow (100%). The yellow/white color (Id) is influenced by the presence of melanin in the epidermal skin layer. The function of the Id gene is to inhibit melanin deposition in the dermis layer of the skin, resulting in a deficiency of melanin and a yellow or white color. The shank color of BS-4 is 100% yellow. The white shank color is caused by a lack of melanin in the dermis layer (albino), and genes regulate the distribution of color. Sartika et al. (2008) state that the yellow/white shank color (Id-) is caused by a lack of melanin in the skin tissue. (dermis).

**Growth of Body Weight in KBC**

The growth of body weight in chicks from DOC to 10 weeks of age, resulting from assortative mating of four mating patterns (Table 2). The growth pattern of AKB from DOC to 10 weeks of age indicates that body weight growth is relatively consistent. The average weight of DOC BS-1 is 24.75±1.09g, BS-2 is 23.50±1.50g, BS-3 is 25.00±1.22g, and BS-4 is 24.00±1.22g. The research results are not much different from the SNI weight of DOC KUB-1 chickens, which is 26g.

**Table 2:** Chick Weight (grams) KBC based on Assortative Mating

| Chicken Age (weeks) | BS-1 | BS-2 | BS-3 | BS-4 |
|---|---|---|---|---|
| DOC | 24.75±1.09 | 23.50±1.50 | 25.00±1.22 | 24.00±21.22 |
| 1 | 30.29±7.48 | 32.50±5.50 | 36.18±7.44 | 32.63±6.40 |
| 2 | 51.44±13.58 | 63.75±15.59 | 62.91±17.89 | 60.92±15.88 |
| 3 | 93.79±18.66 | 110.38±24.17 | 84.55±22.01 | 97.92±29.56 |
| 4 | 132.00±26.44 | 151.13±18.09 | 136.45±24.81 | 149.41±36.03 |
| 5 | 167.53±40.88 | 201.88±29.16 | 182.73±30.57 | 203.15±37.58 |
| 6 | 221.47±58.15 | 291.43±37.12 | 250.36±39.51 | 255.32±56.47 |
| 7 | 270.97±53.71 | 359.00±32.27 | 312.82±54.10 | 326.47±53.87 |
| 8 | 333.47±56.24 | 398.57±28.65 | 383.27±54.80 | 389.74±61.97 |
| 9 | 400.21±58.82 | 447.57±24.84 | 447.45±52.76 | 468.15±51.06 |
| 10 | 478.59±50.51 | 508.86±28.68 | 502.10±52.21 | 534.88±37.21 |

Define in footnote such as BS-1 to BS-4; DOC=A day-old chicks.

The average weight of 10-week-old KBC was the highest in BS-4 at 534.88±37.21g, followed by BS-2 (508.86±28.68), BS-3 (502.10±52.21), and BS-1 (478.59±50.51). The growth patterns of the four breeding patterns are presented in Fig. 1. The growth of KBC from DOC age to 10 weeks tends to show growth. The increase in the body weight of the chickens began to occur in the fourth week, where at the age of 4 weeks, the supply of nutrients in the feed supported growth, leading to the enlargement and multiplication of cells in the chickens' bodies, which included the formation of the skeletal framework, muscles attached to the framework, and the formation of organ muscles (Liu et al., 2016). This study's results are lower than the growth weight of KUB chickens, where at 10 weeks of age, the average weight of KUB-1 has reached 716.71±88.07g.

**Conclusion**

The assortative mating pattern based on the same feather color can be utilized to develop new KBC strains characterized by a dominant feather color. The growth of

KBC resulting from the assortative mating pattern from DOC to 10 weeks of age is relatively the same.

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**Conflict of Interest:** All authors declare no conflict of interest.

**Author Contribution:** Rusfidra planned the experiment and wrote the article. Wiwi Pramita Chania and Harif Gusdinal were responsible for collecting data. Kusnadidi Subekti, Firda Arlina, James Hellyward, Husmaini, and Zasmelli Suhaimi were responsible for interpreting the results and statistically analyzing the data.

**Data Availability:** All the data is available in the article.

**Generative AI Statement:** The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

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