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Variation in the Waveform Patterns of Crowing Sounds and Qualitative Traits of Kokok Balenggek Chickens

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Abstract: The crowing of roosters has two primary purposes: to claim of territory and to attract females. This research aims to describe the waveform patterns of the Kokok Balenggek Chicken (KBC) crowing sound as a genetic resource of the "singing chicken" in West Sumatera Province, Indonesia, and to find qualitative markers. The analysis of the crowing sound was performed on 50 heads adult male roosters. The apparatus characterizing crowing sounds comprises a digital recorder and a stopwatch. The crowing sound is shown in waveform format. The characterization of the crowing sound was ascertained by the time sampling method. The features of crowing sounds were observed in the morning (from 05:00 to 07:00 am) for three consecutive days. The observed parameters included the number of syllables (NS), the number of crowing syllables (NCS), and the waveform pattern of the crowing sound. The qualitative traits examined were feather morphology, feather dispersion, ear lobe color, and foot morphology. The research findings indicated that NCS varied from 4 to 17 crows, with a mean of 4.1±1.8 crows. NS KBC comprises 7 to 20 syllables. The waveform pattern categorizes the crowing sound of KBC into six distinct types: *Ginyang*, *Gayuang Luluh*, *Rantak Gumarang*, *Si Gegek Angin*, *Riak Ilia Aia*, and *Alang Babega* type crow. The qualitative morphological indicators of feathers in KBC include normal feathers (100%), normal feather distribution (100%), and ear lobe hues ranging from red (74.02%), white (19.85%), to reddish-white (6.13%). The prevalence of KBC leg shape variation is 94.81%, while KBC with short legs (creeper) accounts for 5.19%. To enhance ex-situ farming initiatives in West Sumatra Province, it is recommended to cultivate KBC exhibiting standard feather morphology, typical feather distribution, red earlobe color, and conventional leg form variance.

Keywords: Number of crowing syllables, roosters, waveform, plumage morphology, KBC.

Kokok Balenggek 鸡叫声波形模式的变化及其定性特征

摘要：公鸡打鸣有两个主要目的：宣示领土和吸引母鸡。本研究旨在描述印尼西苏门答腊省科科克巴伦格克鸡（KBC）打鸣声的波形模式，作为"歌唱鸡"的遗传资源，并寻找定性标记。对50只成年公鸡的打鸣声进行了分析。打鸣声的特征化设备包括数字录音机和秒表。打鸣声以波形格式显示。打鸣声的特征化通过时间抽样方法确定。观察打鸣声的特征是在早晨（从05:00到07:00）连续三天进行的。观察的参数包括音节数（NS）、打鸣音节数（NCS）和打鸣声的波形模式。检查的定性特征包括羽毛形态、羽毛分布、耳垂颜色和足部形态。

研究结果表明，NCS的数量从4到17只乌鸦，平均为4.1±1.8只。NS KBC由7到20个音节组成。波形模式将KBC的鸣叫声音分为六种不同类型：Ginyang、Gayuang Luluh、Rantak Gumarang、Si Gegek Angin、Riak Ilia Aia和Alang Babega类型的鸣叫。KBC羽毛的定性形态学指标包括正常羽毛（100%）、正常羽毛分布（100%），以及耳垂颜色范围从红色（74.02%）、白色（19.85%）到红白色（6.13%）。KBC腿型变异的流行率为94.81%，而短腿KBC（爬行者）占5.19%。为了增强西苏门答腊省的场外养殖项目，建议培养表现出标准羽毛形态、典型羽毛分布、红色耳垂及常规腿型变异的KBC。

关键词：鸣叫音节数、雄鸡、波形、羽毛形态、KBC.

1. Introduction

Poultry farming significantly serves human interests, particularly as a source of animal protein. Furthermore, livestock serves as an essential source of revenue, savings (bio-investment), labor, transportation, biogas production, organic fertilizer production, and companionship [1] and [2]. Consequently, [3] and [4] underscore the significance of livestock in enhancing the quality of human existence. Village chickens represent a category of indigenous poultry extensively maintained by the Indonesian community. In addition to their popularity as sources of meat and eggs, the local chickens can serve as ornamental birds, fighting birds, and singing chickens. Local hens exhibiting melodious crowing should be cultivated as singing chickens. The local chickens identified as potential singing chicken in Indonesia are KBC, Pelung chicken, Bekisar chicken, and Gaga chicken. These four indigenous chicken varieties possess lovely crowing sounds, are enjoyable to hear, and are preferred by numerous songbird aficionados [5]. The melodious and distinctive crowing of the KBC is regarded as the sole chicken breed globally exhibiting the *balenggek* crowing type [1] and [5]. KBC occupies a prominent status within the Minangkabau ethnic group [6]. In 2011, KBC was officially recognized as a national poultry breed by the Ministry of Agriculture [1] and [5]. The popularity of KBC as a singing chicken in West Sumatra Province has surged over the past ten years, attributed to contests conducted by the government and its aficionados [5].

Extensive research on KBC has been conducted by various researcher encompassing investigations into the characteristics of crowing sounds [7], assessments of KBC semen and fertility [8], the viability of KBC as meat chickens [9], analyses of sperm quality in KBC [8], reproductive dynamics of KBC post-artificial insemination [10], and studies on qualitative and quantitative markers of KBC base generation (G0) [9].

Presently, in the central population zones, the quantity of KBC is diminishing due to the sale of numerous KBC outside these areas, and KBC characterized by prolonged crowing sounds (multiple syllables) are

becoming progressively scarce in their native region of Tigo Lurah District, Solok Regency. The KBC population has significantly diminished due to outbreaks of newcastle disease (ND) and the restricted number of KBC contests. Given these circumstances, measures are required to safeguard the KBC from extinction, including both in situ conservation in key regions and ex situ conservation outside these areas [1].

Genetic variety is crucial in livestock breeding initiatives, as comprehending the genetic variation among chicken enables the development of new breeds through selective breeding methodologies. Qualitative markers in chickens can be discerned by analyzing feather morphology, feather distribution, ear lobe pigmentation, and leg form differences [11].

The harmonious, multi-layered crowing sound of KBC, a variety of singing chicken, provides an enjoyable listening experience. KBC serves as a genetic repository for singing chickens in West Sumatra. The melodious and distinctive crowing of the KBC is believed to be the sole breed of chicken globally exhibiting the balenggek crowing type [1]. The Minister of Agriculture's Decree No. 2919/Kpts/OT.140/6/2011 recognizes the KBC as a national livestock breed. The syllable of the crowing is the distinct sound that aggregates into a tightly interwoven set of sounds, with evident segmentation between the syllables. Six to twelve syllables, with an average of 8.07 syllables, make up the NCS KBC. NCS is crucial in the execution of contests and the establishment of KBC selling prices. The bigger the number of NCS, the higher the selling price of KBC and the increased likelihood of winning the crowning contest [1]. The population of KBC in the central region is presently declining due to the sale of many KBC outside this area, and even those with extended crowing (many syllables) are seldom encountered in their native locality of Tigo Lurah District, Solok Regency. The KBC population has significantly diminished due to the Newcastle disease outbreak and the absence of KBC competitions. Given these conditions, we must implement measures to conserve the KBC and avert extinction, both through in-situ conservation in central locations and ex-situ conservation beyond those areas.

2. Methodology

This study involved 50 adult male KBC roosters that had reached crowing maturity. The sample size aligns with recommendations [11], for phenotypic characterization, which suggest 10 to 30 subjects as sufficient for meaningful assessment. The apparatus employed for the characterization of crowing noises consists of a digital recorder and a timer. The vocal features of the KBC were observed in the morning [12, 1]. We examined the KBC crowing sound using the Cool Edit Pro software. We captured the KBC crowing sound using a digital recorder. The software facilitates sound analysis (visualization), sound waveform identification, and crowing duration measurement. This investigation utilized 50 adult male KBC samples. The sample size adheres to the guideline [11], which stipulates that a sample size of 10 to 30 male chickens is necessary for the definition of qualitative features in poultry.

The study examines the number of crowing syllables (NCS) as the variable. NCS by subtracting tree points from the total number of crowing syllables and examining the crowing sound. The analysis of crowing sounds using Sound Cool Edit Pro software aims to determine the number of syllable (NS) of KBC, thereby facilitating the selection of roosters with melodious crowing sounds. A waveform visually represents the crowing [1]. We classify the morphology of chicken feathers into normal feathered birds, frizzle (reverse feather) chickens, and silky chickens. We classify the distribution of feathers into typical feathered chickens, naked neck chickens, and feathered leg chickens. The classify the hue of the earlobe into three categories: white, red, and reddish white. We classify leg form variations into normal-legged chickens, polydactyl chickens, short-legged chickens (creepers), and dwarf chickens.

3. Results

Number of Syllables (NS)

The syllables of the crowing consist of sounds organized into a cohesive cluster, with a distinct separation between the syllables [1]. The syllable count in the KBC crow varies from 4 to 17 crow syllables. The average NS of KBC is inferior to the NS of KBC in the center region of Tigo Lurah District. According to [1], the number of KBC syllables in the center region ranges from 6 to 12 syllables, with an average of 8.07 syllables.

Number of Crow Syllables (NCS)

We calculate the NCS by subtracting three points from the total number of syllables in the crow [1]. The number of NCS in KBC ranges from 2 to 14 with an average of 4.1±1.8 crows. According to [1], the NCS of KBC in the central area of Tigo Lurah District ranges from 3 to 9 crows, with an average of 5.07 crows.

AKB Crowing Sound Pattern

The Cool Edit Pro program's analysis of the crowing sound waveform reveals that one sequence of the crowing sound consists of three elements, as shown in Figure 1.

1. Front crow; consists of the first crow syllable.
2. The middle crow is composed of the second and third crow syllables, and
3. The back crow begins with the fourth crow syllable and continues from there "Lenggek kokok" [1] refers to the back part of the crowing process.

The classification of KBC crowing sounds into three elements (front, middle, and back crowing) is based on the grouping of visually adjacent crowing syllables and the amplitude (loudness) of the crowing sound. In addition, there is a clear fragmentation between the elements of the crowing sound. KBC has a distinctive crowing pattern, different from the crowing patterns of Pelung chickens, Bekisar chickens, Kampung chickens, and Gaga chickens. One can use the waveform pattern of the crowing sound as a breed marker in chickens.

Waveform Pattern of Rooster Crowing Sound

There are six types of KBC sounds: the *Ginyang* sound, *Rantak Gumarang*, *Gayuang Luluah*, *Si Gegek Angin*, *Riak Ilia Aia*, and *Alang Babega* (Figure 1 – 6). The crowing sound pattern of KBC *Ginyang* is unstable and irregular. Figure 1 displays the waveform pattern of KBC *Ginyang*. The unstable, variable, and irregular crowing sound is a combination of two or more sounds, causing listeners to laugh. Figure 1 illustrates that the *Ginyang* voice KBC features 17 crowing syllables and rowing trills, exhibiting a crowing duration of 3.551 seconds. The *Ginyang* voice KBC has a shorter crowing duration compared to the Gaga-type Dangdut's long class (30.83 seconds), short class (4.20 seconds), and slow type (3.68 seconds) [15].

Figure 1. *Waveform* pattern of KBC *Ginyang* Type

Figure 2. *Waveform* pattern of KBC *Rantak Gumarang*

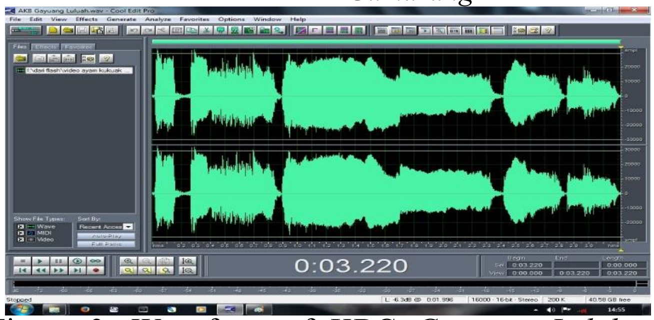

Figure 3. Waveform of KBC *Gayuang Luluh* type

Figure 4. Waveform pattern of KBC *Sigegek Angin*

Figure 5. W*aveform* pattern KBC *Riak Ilia Aia*

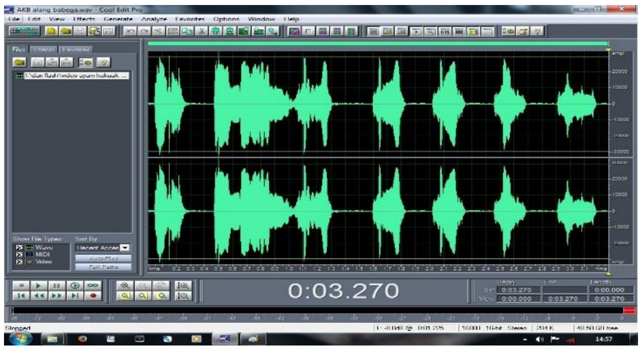

Figure 6. Waveform pattern of KBC Alang Babega

Morphology of Feathers

The feather morphology of KBC is entirely normal (Figure 7). Genetic factors, specifically the Na gene, cause normal feather morphology. We did not find KBC with reversed feathers or silk feathers. The gene frizzle influences chickens with reversed feathers, while the silky gene influences chickens with silky feathers. Therefore, we suspect that the F gene and the silky gene have not yet flowed into the KBC population. The dominance of the normal feather gene in KBC with normal feathers is believed to have come from the ancestors of domestic chickens, specifically the Red Jungle Fowl [17].

Figure 7. KBC Normal Feather

Feather Distribution

The feather distribution of KBC is entirely normal. There are no KBC without neck feathers, also known as a naked neck, and no KBC with feathered legs (Figure 7). The expression of the naked neck gene (Na) influences chickens without a naked neck. Therefore, we suspect that the naked neck chicken gene and the feathered leg chicken gene have not yet found a flow in KBC.

Fig. 8a. Earlobe Red Color

Fig 8b. Earlobe White Color

Earlobe color of the KBC in order is red (74.02%) (Fig. 8a), white (19.85%) (Fig. 8b), and reddish white (6.13%). The color of the KBC earlobe is different from the color of the Burgo chicken earlobe in Bengkulu. The Burgo chicken has white earlobes.

The variation in KBC foot shapes includes normal foot shapes (94.81%) and short-legged chickens (5.19%). We did not find KBC chickens with extra toes (polydactyly) or dwarf ones. The dwarf gene, specifically the dw gene, influences dwarf chickens [18]. The Creeper gene influences short-legged chickens, while the polydactyly gene causes polydactyly chickens [19].

4. Discussions

Number of Syllables (NS)

The number of KBC crow syllables exceeds that of the Pelung and Bekisar chickens. Pelung hens produce a three-syllable crow with an extended pitch. The Pelung rooster's crow lacks a distinct interval between syllables; yet there is a variation in volume between the starting sound and the middle sound, as well as between the middle sound and the final sound [1]. The Pelung rooster's crow has a front sound, a middle sound, and a final sound, while the Bekisar rooster's crow consists of two syllables: the front sound and the back sound. People perceive the Bekisar rooster favorably if its front sound is low, substantial, robust, elongated, and clear, while its back sound is high, dense, elongated, direct, and clear. The NS of KBC is higher than the number of NS of Pelung and Bekisar chickens.

The Pelung chicken has three syllables in its crow and has a long pitch. There is no clear interval between the syllables of the Pelung rooster's crow, but there is a change in volume between the initial and middle sounds and between the middle and final sounds [1]. According to [13], the Pelung rooster's crow consists of a front sound, a middle sound, and a final sound, while the Bekisar rooster's crow consists of two syllables: the front sound and the back sound [1]. The Bekisar rooster is considered excellent if the front sound has a low, large, thick, long, and clear tone, while the back sound has a high, thick, long, straight, and clear tone [1].

Number of Crow Syllables (NCS)

We suspect that the variation in the number of crowing intervals among KBC is a form of individual variation. This aligns with the findings of [14], a researcher on songbirds, who found that there is variation in songs among individuals within a species and among different species of songbirds.

AKB Crowing Sound Pattern

The crowing sound in roosters is a secondary sexual characteristic that serves two main functions: as a claim of territorial dominance and as an attraction to entice hens they wish to mate with. We can use the sound as an indicator of animal welfare, an emotional expression, and a measure of the animal's physiological status [1].

Waveform Pattern of Rooster Crowing

The *Rantak Gumarang* crowing pattern has a clear crowing sound with regular intonation and a crowing pressure similar to the sound of a horse's hoof racing to the finish line (Figure 2). Figure 2 illustrates that the *Rantak Gumarang* crowing pattern features 7 syllables and 4 crowing embellishments, boasting a crowing duration of 3.544 seconds. The KBC which uses the *Rantak Gumarang* voice type, has a shorter crowing duration than the Gaga Dangdut type long class (30.83 seconds), short class (4.20 seconds), and slow type (3.68 seconds) [15]. It also has a shorter crowing duration than the Pelung chicken (3.0–8.9 seconds) [13].

KBC *Gayuang Luluh* has a long crowing sound that touches the hearts of those who hear it (Figure 3). KBC *Gayuang Luluh* has 5 syllables in its crow and 2 syllables in its coo, with a crowing duration of 3.22 seconds. The crowing duration of KBC *Gayuang Luluh* is shorter than that of the Gaga-type Dangdut long class (30.83 seconds), short class (4.20 seconds), and Slow type (3.68 seconds) [15], as well as shorter than that of the Pelung chicken (3.0 – 8.9 seconds) [13].

Figure 4 depicts the vibrating crowing sound of KBC *Si Gegek Angin*, which has a rapid and stuttering rhythm. KBC *Si Gegek Angin* has 9 syllables in its crow and 6 trills, with a crowing duration of 3.22 seconds. KBC *Si Gegek Angin* has a shorter crowing duration compared to the Gaga type Dangdut long class (30.83 seconds), short class (4.20 seconds), and slow type (3.68 seconds) [15]; shorter than the Pelung chicken (3.0–8.9 seconds) [13]; and shorter than the Toutenko, Toumaru, and Koeyoshi chickens from Japan, which have a crowing duration of 15 seconds [16].

KBC *Riak Ilia Aia* to an KBC whose crowing voice resembles a river flowing from a high place to a low place. KBC with this crowing pattern has a high crowing frequency in the initial syllables and tends to decrease until the final crowing syllables (Figure 5). KBC *Riak Ilia Aia* has 9 crowing syllables and 6 crowing pitches, with a crowing duration of 3.222 seconds. The crowing duration of KBC *Riak Ilia Aia* is shorter than that of the Gaga chicken type Dangdut long class (30.83 seconds), short class (4.20 seconds), and slow type (3.68 seconds) [15]. It is also shorter than the crowing duration of the Pelung chicken (3.0–8.9 seconds) [13] and shorter than the crowing duration of Japanese singing chickens, Toutenko, Toumaru, and Koeyoshi, which have a crowing duration of 15 seconds [16].

KBC *Alang Babega* resembles an eagle circling in the sky, stalking its prey with its crowing sound pattern. The KBC produces a loud crowing sound that is audible from a considerable distance. (Gambar 6). KBC *Alang Babega* has 7 syllables in its crow and 4 crowing gestures, with a crowing duration of 3.27 seconds. KBC *Alang Babega* has a shorter crowing duration compared to the Gaga chicken of the Dangdut type, long class (30.83 seconds), short class (4.20 seconds), and slow type (3.68 seconds) [15], shorter than the crowing duration of the Pelung chicken (3.0–8.9 seconds) [13], and shorter than the crowing duration of Japanese singing chickens, namely Toutenko, Toumaru, and Koeyoshi, which have a crowing duration of 15 seconds [16].

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Earlobe color of the KBC in order is red (74.02%), white (19.85%), and reddish white (6.13%). The color of the KBC earlobe is different from the color of the Burgo chicken earlobe in Bengkulu. The Burgo chicken has white earlobes.

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5. Conclusions

Based on the analysis and discussion, the following conclusions can be drawn:

The number of crowing syllables (NCS) in Kukuak Balenggek Chicken (KBC) ranges from 4 to 17 syllables, with an average crowing length of 4.1 and a total range of 2 to 14 distinct crowing notes.

Among the KBC samples, the Biriang variant demonstrated the most extensive vocalization, producing 17 syllables and 14 crowing notes, making it the longest crowing individual observed in the study.

The waveform analysis of crowing sounds proved to be an effective and objective method for quantifying the number of syllables (NS) and crowing notes (NCS), allowing for accurate and reproducible assessments of vocal traits.

In terms of phenotypic characteristics, all observed KBC specimens exhibited normal feather morphology and feather distribution. The dominant earlobe color was red, recorded in 74.02% of individuals, while leg morphology was predominantly normal in 94.81% of the population.

These findings contribute to a deeper understanding of the acoustic and morphological traits of KBC and support future efforts in selective breeding and conservation of this unique indigenous chicken breed.

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Author Contributions

Rusfidra designed the study and drafted the manuscript. K. Prasetyo and Mh. Desra were responsible for data collection. Y. Heryandi, Kusnadidi Subekti, and Firda Arlina contributed to data interpretation and performed statistical analysis.

Conflicts of Interest

The authors declare no conflict of interest.

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