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Review Article

Development of Indian Runner Ducks: Indonesia's Original Germplasm Superior Laying Duck

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Abstract

Objective: This review article aims to provide a comprehensive overview of the origins of the Indian Runner duck and its development as a significant source of egg production in Indonesia. It reviews recent scientific literature on the topic, synthesizing findings from various studies.
Methods: Analysis of the data reveals that the Indian Runner duck descends from the wild green-headed Mallard, which was domesticated in both mainland China and Indonesia.
Results: The qualitative and quantitative traits of Indian Runner ducks are exceptionally high, making them suitable for various selection purposes. Specifically, selection processes have been implemented for egg production in Mojosari ducks, leading to the development of Mojomaster-Agrinak ducks, as well as in Alabio ducks, resulting in Alabimaster-Agrinak ducks. The crossbreeding of Mojomaster-Agrinak ducks as the male line with Alabimaster-Agrinak ducks as the female line yields superior hybrid offspring known for their auto-sexing characteristics.
Conclusion: Ultimately, Mojomaster and Alabimaster ducks are recognized as superior laying duck varieties, with their interbreeding producing commercial laying ducks that exhibit auto-sexing traits at the day-old (DOD) stage.

Keywords: Alabimaster-Agrinak; Diversity of phenotypes and genotypes; Indian Runners; Mojomaster-Agrinak

INTRODUCTION

Ducks play a crucial role in supporting national food security in Indonesia, with egg production showing a consistent upward trend over the years. In 2012, meat production reached 33,610 tons [1], which increased by 31.5% to 44,198 tons in 2022 [2]. Similarly, egg production rose from 275,938 tons in 2012 [1] to 363,135 tons in 2022, marking a 24% increase [2]. Traditionally, duck rearing in Indonesia followed the umbaran pattern, where ducks grazed across rice fields; however, the intensification of agricultural practices has led to a transition from this extensive system to a more intensive and confined approach. This change aims to mitigate duck mortality caused by pesticide residues in

grazing areas and is also influenced by the conversion of paddy fields into urban development areas such as housing and commercial facilities.

The transition in duck cultivation systems faces challenges, as the level of egg production does not align proportionately with the incurred feed costs, primarily due to the significant genetic variation among different duck breeds. For instance, research on Tegal ducks indicates that only 4% of the population can produce over 301 eggs annually, while 29%, 32%, and 21% produce between 241 to 300, 201 to 240, and 141 to 200 eggs per year, respectively. Additionally, about 6% and 8% of Tegal ducks produce between 101 to 140 eggs and fewer than 100 eggs annually [3]. Genetic improvement efforts have been underway for several decades, beginning with an inventory of local duck genetic resources and their qualitative and quantitative traits, followed by a selection program. These initiatives have led to the development of superior laying ducks known as hybrid master auto-sexing ducks, which have been introduced into the community. This paper aims to describe the origins, genetic diversity, and production capabilities of Indian Runner ducks, as well as the ongoing efforts for genetic enhancement, providing readers with a comprehensive understanding of both the breed's origins and the strategies employed to improve its genetic diversity.

INDIAN RUNNER DUCK AS A POTENTIAL FOOD PROVIDER

The Indian Runner duck is a domesticated breed that originated from the green-headed Mallard wild duck. [4-5]. Although the exact timing of its domestication remains unclear due to limited archaeological evidence. Historical records indicate that ancient Egyptians did not engage in duck domestication, relying instead on wild ducks for meat and eggs [4]. The primary centers of domestication were Southeast Asia and China, where the process involved selective breeding that resulted in diverse broiler and layer ducks with various phenotypes and genetic traits. By 500 BC, the domesticated ducks had spread globally, evolving into a significant source of poultry for meat and egg production [6]. This domestication led to notable behavioral changes, including the loss of brooding instincts, a shift from monogamy to polygamy, and an increased tendency for terrestrial living [7-8]. Additionally, the selection process influenced physical characteristics; broiler-type ducks developed a wide, deep body shape with rapid growth rates, while laying ducks became smaller and slenderer with an upright posture, reaching sexual maturity between 121 to 142 days [9-10]. In contrast, Pekin ducks exhibit earlier maturity at age of 194 days [11].

Indian Runner ducks, native to Indonesia, have now spread globally [12]. They were first introduced to the UK around 1930 via a merchant ship from the East India Company [13]. Despite their name suggesting an Indian origin, the Indian Runner ducks actually originate from the Indonesian islands of Java, Bali, and Lombok. The name "Indian Runner" is misleading; it reflects a common misconception about their geographical roots [11]. The breed is characterized by its unique upright posture and remarkable running ability, which were developed through selective breeding practices. Initially observed in ancient carvings in Java, these ducks have been recognized for their utility as both meat and egg producers. Their introduction to Europe occurred in the mid-19th century, where they gained popularity for their prolific egg-laying capabilities.

Since the last few decades, Indian Runner ducks have become a vital source of poultry for meat and egg consumption, holding a position comparable to native chickens, broilers, layers, cattle, buffalo, and other livestock. Their significance is underscored by the fact that their

products cannot be substituted by other poultry, particularly in the production of salted eggs. In terms of population, ducks rank fourth after broiler chickens, native chickens, and laying breeds [2]. The duck population has shown a notable increase, rising from 49,392,000 heads in 2012 to 58,651,838 in 2022, reflecting a growth of 15 percent [1-2]. This upward trend in duck farming highlights their importance in the agricultural sector and their contribution to national food security.

BIODIVERSITY OF THE INDIAN RUNNER DUCK

Indian Runner ducks are widely distributed across Indonesia, where they are known by various names or designations. Key characteristics of this breed include a long, wedge-shaped head; a beak that is fused with the head; a shallower head with eyes positioned higher than those of other duck types, giving them a cheerful appearance; a long and slender neck; and a slender, rounded body. Additionally, Indian Runner ducks are known for their greenish-white egg shells. These traits contribute to their unique profile within the poultry industry, highlighting their importance in both local and international markets [14-16].

Research on the characteristics of Indian Runner ducks has been ongoing for approximately 50 years [17], with significant studies focusing on various regional breeds. For instance, Herliani et al. [18] conducted observations on the performance and potential development of Alabio ducks in South Kalimantan, while Suryana et al [19] explored their genetic characteristics. Similar investigations have been carried out on other duck breeds, including Cihateup [20], Mojosari, Magelang [21], Turi [22], Bali [23], Pitalah [24], Kamang [25], Bayang [26], Pegagan [27], Talang Benih [28], and Lombok ducks [29]. Moreover, genetic studies on Tegal and Magelang ducks as well as Mojosari ducks have employed morphological approaches and blood serum protein profiles, as reported by Maharani et al [30] and Purwantini et al [31].

The results of the inventory of qualitative traits, particularly variations in feather color and body posture of Indian Runner ducks from Java and Nusa Tenggara, are detailed in Table 1, while Table 2 presents the types of ducks developed on the islands of Sumatra and Kalimantan. The naming conventions for the ducks listed in these tables predominantly reflect their regions of origin. For example, Indian Runner ducks from Java and Nusa Tenggara include Tegal ducks, Mojosari ducks, Magelang ducks, Turi ducks, Bali ducks, Lombok ducks, and Cihateup ducks, each named after their respective areas: Tegal, Mojosari, Magelang, Turi (Jogjakarta), Bali, Lombok, and Cihateup hamlet in Rajamandala Rajapolah village, Tasikmalaya, West Java [10, 32]. Similarly, the names of Kerinci ducks, Talang Benih ducks, Bayang ducks, and Kamang ducks derive from their origins in Kerinci district (Jambi), Talang Benih village (Rejang Lebong, Bengkulu), Bayang district (South Coastal district, West Sumatra), and Kamang village (Tilatang Kamang district, West Sumatra) [10, 32]. Notably, only four duck species do not follow this regional naming pattern: Pegagan ducks from Kotodoro Tanjung Raja Ogan Ilir (South Sumatra), Pitalah ducks from the Minang domain, Damiaking ducks from Pontang Tirtayasa (Tanara, Lebakwangi District Serang) [33], and Alabio ducks from the lower river region of South Kalimantan [10, 31].

Indian Runner ducks exhibit a wide diversity of feather colors across different breeds. For instance, Tegal ducks are noted to have between 7 to 9 color variations [33], while Mojosari ducks possess 2 colors [33], Lombok ducks feature 5 distinct colors [29], and Alabio ducks also display 5 color variations [34]. This diversity is consistent among other types of Indian Runner ducks, indicating that each breed possesses a unique range of feather colors.

However, some breeds may share similar colors but have different designations. A notable example is the dominant feather color of Tegal ducks, referred to as "branjangan," meaning dry straw in Javanese. In contrast, this same color is called "Damiaking" in Sundanese, "sumi" in Balinese, and "roman" or "jami" in Sasak (Lombok) terminology [24]. The prevalence of the dry straw feather color is widespread across Java, Bali, and West Nusa Tenggara, highlighting the rich cultural and linguistic diversity associated with these breeds [10, 32].

The feather colors of Indian Runner ducks, particularly those found on the island of Sumatra, exhibit a range of hues including brown, gray, and black [10]. Notable breeds with dominant colors include Pegagan ducks from Kotodoro Tanjung Raja in Ogan Hilir, South Sumatra [35]; Talang Benih ducks from Talang Benih village in Rejang Lebong, Bengkulu [35]; and Pitalah ducks from Ranah Minang [24]. Additionally, Bayang ducks from Bayang sub-district in South Pesisir Regency [26, 36] and Kamang ducks from Kamang village in Tilatang Kamang District, West Sumatra [25], predominantly display brownish-brown colors. Male Kerinci ducks are characterized by white with brown spots on the neck, chest, and back, while their tails feature a mix of brown and blue-black. In contrast, female Kerinci ducks have a base of white feathers with light brown spots extending from the chest to the tail tip and dark wings [37]. Alabio ducks from Sungai Hulu in South Kalimantan showcase five feather colors: grayish brown, bluish green, grayish white, blackish ash, and black [34]. Among these breeds, only Alabio ducks retain feather colors similar to their wild ancestor, the green-headed Mallard; the other breeds exhibit significantly different feather coloration.

Referring to the data presented in Tables 1 and 2, it is evident that 79% of the egg-laying ducks distributed throughout the Indonesian archipelago exhibit an upright body position while standing and walking, in contrast to the remaining ducks that retain a horizontal posture akin to their wild ancestor, the green-headed Mallard. This variation in body posture is attributed to selective breeding practices and the time elapsed since domestication. Specifically, duck breeds such as Pegagan, Talang Benih, and Pitalah ducks are characterized by their horizontal stance [35]. This indicates that, from a standing perspective, a significant majority, accounted for 79% of ducks in Indonesia share close genetic relationships, reflecting the influence of breeding on their physical traits.

Table 1. Qualitative characteristics of Indian Runner ducks developed on the islands of Java and Nusa Tenggara

Duck Name	Color	Body Shape
Cihateup Ducks	The color of the feathers on the whole body is brick red with white batik-patterned wing tips	When standing upright, it forms a 90-degree angle, when relaxed, it leans forward to form an angle of 60-70 degrees
Damiaking Ducks	Fur color is damiaking (dami = straw, aking = dry)	A slim body, long neck, and in an upright position, it looks like a bottle
Cirebon Ducks	The feathers on the head, neck, chest, back and wings are brown or spotted brown, and with light brown thighs	Slim body with a bottle-shaped head, neck, and back
Turi Ducks	Male Turi ducks are black on the neck, and blackish brown on the body. Female Turi ducks are brown on the neck, and light brown, and brown striations on the body	Turi ducks look like bottles with a forward leaning position

Magelang Ducks	Magelang ducks are characterized by tanned feathers with variations of light to dark brown or blackish and often found black totol color, and have a necklace on the neck white with a size of about 1-2 cm	Magelang ducks (male and female) have a slim body posture, when standing and walking they seem to be upright, perpendicular to the place where they stand
Tegal Ducks	Adult duck feather color is dirty white-brown (branjangan), light brown with thin brown spots (lemahan), light brown with thin black spots (jarakan), plain white, blackish brown or dark black	The posture of the Tegal duck is slim, upright and bottle-like
Mojosari Ducks	Mojosari ducks have two colors (white and reddish brown). The chest of the male is blackish brown. the female is brown. The back of the male is blackish brown. With a whitish gray belly-thigh area, and the female is brown with black stripes	The body shape of the mojosari duck is slender like a bottle
Bali Ducks	There are 3 types of Bali duck feather colors, namely Sumi, Sumbian and Singkep feathers	Balinese ducks have a small, slender body with an upright posture when walking
Lombok Ducks	The dominant coat color is roman or jami (dry straw), followed by milestone, rombak and cemaning	Classified as a medium-sized duck. The body position when walking is upright, and slightly down when resting

Source: Tamzil [10]

Table 2. Qualitative characteristics of Indian Runner Ducks developed on the islands of Sumatra and Kalimantan

Ducks Name	Color	Body Shape
Pegagan Ducks	Male ducks are grayish from the head, neck, wings, back and tail, while females are blackish brown with shiny blue-black wings. The tail feathers of both males and females are shiny blue-black	Round and flat body shape with a standing position forming a 45-degree angle
Kerinci Ducks	The feather color of male ducks is white with brown spots (dominant). On the neck, chest, and back and the tip of the tail is a mixture of brown and blue-black (glap). Female ducks are characterized by white base color feathers, bright brown spots from the chest to the tip of the tail and wings	Upright body posture forming an angle of 70-80 degrees in males, 40-45 degrees for females
Talang Benih Ducks	The feathers on the body of male Talang seed ducks are gray, while the females are black to brown brajangan	Short, compact, compact body posture, relatively short and large neck and legs, relatively large head
Pitalah Ducks	Pitalah duck feather color is dominated by black spots, with black, light yellow and dark yellow shank colors	Slender body posture is slightly upright, when walking the body position is horizontal
Bayang Ducks	The feather color of the Bayang duck is dominated by a brownish-brown color, with the shank color entirely black	Slender and slightly upright body posture

Kamang Ducks	From head to tail is brown, accompanied by white above the eyes and a white ring (kalong) on the neck	Data not available
Alabio Ducks	Has five kinds of feather colors: grayish brown, bluish green, grayish white, blackish ash, and black.	Slender body with upright position like a bottle

Source: Tamzil [10]

PRODUCTION PERFORMANCE OF THE INDIAN RUNNER DUCK

The production performance of Indonesian Indian Runner ducks is detailed in Table 3, which categorizes body weight into large, medium, and small sizes. Ducks classified as large include Pegagan, Kerinci, Talang Benih, Alabio, and Turi ducks. The medium-sized category comprises Damiaking, Cirebon, Magelang, Tegal, Mojosari, and Lombok ducks. Small-sized ducks include Pitalah, Bali, Cihateup, and Kamang ducks. The generally low average body weight across all types of Indian Runner ducks is attributed to their classification as laying-type ducks, characterized by a small and slender body posture. In contrast, broiler ducks are recognized for their wide, deep, and compact body shapes, which are accompanied by denser and more filled bodies [8].

The performance data of Indian Runner ducks presented in Table 3 indicates that Cirebon ducks exhibit early sexual maturity at approximately 4 months of age. In contrast, Talang Benih ducks mature later at 6.5 months, while Pitalah, Alabio, and Bayang ducks reach sexual maturity at 6 months, 5.6 months, and 5.5 months, respectively [10]. Ducks that mature early are generally less effective as producers of consumption eggs due to the smaller size of their eggs, while those with later sexual maturity are also less desirable for egg production because of the higher costs associated with raising them to maturity. The late sexual maturity observed in some duck breeds is linked to genetic factors that cannot be influenced by non-genetic variables such as feed quality or light intensity [36]. For optimal egg production, it is recommended to select ducks that reach maturity between 151 to 170 days of age [37]. Additionally, the data reveals that Balinese ducks have the highest egg production capabilities among Indonesian Indian Runner ducks, followed by Talang Benih and Turi ducks, while other breeds show relatively similar production abilities. Furthermore, Pegagan and Talang Benih ducks are noted for having the largest egg weights, whereas other Indian Runner duck species exhibit comparable egg weights.

Table 3. Production performance of several breeds of Indian Runner ducks in Indonesia.

No	Ducks Name	Body Weight (g)	Sexual Maturity (days)	Egg Production	Egg Weight (g/grain)
1	Cihateup Ducks	1475.61[10)]	142±9[11)]	180-200 grain/year[11)]	-
2	Damiaking Ducks	1523,26[12)]	152 [13)]	200 grain/year[13)]	-
3	Cirebon Ducks	1555,24[12)]	121[14)]	-	48,04-54,38[14)]
4	Turi Ducks	1500–1800[14)]	-	200-230 grain/year[14)]	66,4 ±0,9[14)]
5	Magelang Ducks	1523,26[14)]	-	75.44 %[3)]	67–69[4)]
6	Tegal Ducks	1571,18[14)]	-	64.89 %[3)]	66.15[3)]
7	Mojosari Ducks	1544±120[1)]	168±21[1)]	128±23[1*)] 205±48[1**)]	57.71[1)]

8	Bali Ducks	1480[2)]	-	200-260 grain/year[2)]	
9	Lombok Ducks	1613.82[5)]	154[5)]	-	65.47[5)]
10	Pegagan Ducks	1700-1900[6)]	153-154[6)]	170-200 grain/year	70-80 g[6)]
11	Kerinci Ducks	1500-1700[7)]	141-164[7)]	170-200 grain/year[7)]	55-60[7)]
12	Talang Benih Ducks	1600[8)]	195[8)]	200-250 grain/year[8)]	72,5±2,6[8)]
13	Pitalah Ducks	12200[6)]	179±31[6)]	180 – 200 grain/year[6)]	64[6)]
14	Bayang Ducks	1500[6)]	165[6)]	184-215 grain/year[6)]	65±6[6)]
15	Kamang Ducks	1340[9)]	=	-	-
16	Alabio Ducks	1608.14±13[1)]	168±17.16[1)]	115±29[1*)] 204±45[1**)]	60-62[15)]

Description: *: Production up to 3 months of age (grains). **: Production until 6 months of age (grains), 1): Damayanti et al. [49]. 2): Ismoyowati and Purwantini [38], 3): Ismoyowati et al. [40], 4): Purwantini et al. [31], 5): Tamzil and Indarsih [29], 6): Sari et al. [27], 7): Nur et al. [38], 8): Kususiyah et al. [28]. 9): Arlina et al. [25], 10): Lan et al. [29], 11: Procula and Suryana [17], 12): Tamzil [29], 13): Tamzil [30], Wulandari et al.[41],. 15): Sulaiman and Basransyah [43].

GENETIC IMPROVEMENT OF THE INDIAN RUNNER DUCK

The primary challenge facing the laying duck industry in Indonesia is the lack of breeders capable of producing high-quality seeds. The seeds sourced from various duck farming centers exhibit significant variability in quality, leading to a mix of ducks with both high and low egg production capabilities. This inconsistency results in inefficient feed utilization, asynchronous sexual maturity, and an inability to achieve peak production levels. As a consequence, prioritizing selection programs aimed at producing superior seedlings is essential for improving the overall productivity and sustainability of the industry.

The high genetic diversity of Indian Runner ducks is well-documented through research utilizing microsatellite markers, particularly in studies focusing on Tegal, Magelang, and Mojosari ducks [38]. These studies revealed a close genetic relationship between Tegal and Magelang ducks (genetic distance of 0.1722), while a greater genetic distance was observed between Tegal and Mojosari ducks (0.3251). Further evidence of genetic diversity comes from Single Nucleotide Polymorphism (SNP) analysis conducted on the D-loop region of mitochondrial DNA across various breeds, including Magelang, Tegal, Mojosari, Balinese, and Alabio ducks [39]. The results indicate a nucleotide sequence similarity of 99.68 ± 0.56% among the studied Indian Runner ducks, with an SNP diversity value in the D-loop region of mitochondrial DNA measured at 0.32 ± 0.56%. Specific SNPs were identified across various color variants of Magelang ducks, including Klawu blorok, Black cemani, Gambiran, Jarakan kalung, Jowo polos, and White polos, as well as in Tegal ducks. This research concludes that the Indian Runner ducks analyzed comprising Magelang, Tegal, Mojosari, Balinese, and Alabio ducks exhibit high genetic diversity [39]. To leverage this genetic potential for improved egg production, prioritizing selection programs aimed at producing superior seeds is essential.

Accelerating the selection program for Indian Runner ducks can be effectively achieved by integrating both direct and indirect selection systems. Direct selection focuses on traits related to growth and meat quality, allowing breeders to choose individuals based on observable performance characteristics. In contrast, indirect selection involves selecting traits based on

markers such as morphological, biochemical, or DNA/RNA diversity that are associated with growth, meat quality, and egg production traits. This approach is known as marker-assisted selection (MAS) [43].

A pilot project aimed at producing superior ducks has been conducted at the Livestock Research Center in Ciawi, Bogor, focusing on the selection of Mojosari and Alabio ducks. The selection process over several generations has resulted in the development of Mojomaster ducks, whose production performance is detailed in Table 4. These selection results have been introduced to the community under the name Mojomaster-1 Agrinak duck [44]. The Mojomaster-1 Agrinak strain is derived from Mojosari ducks that were imported to the Ciawi Livestock Research Center in 1998 from the Mojosari sub-district in Mojokerto district, East Java [45].

Local duck selection programs have been successfully implemented for Alabio ducks in South Kalimantan, resulting in the development of Alabimaster ducks [46]. These ducks exhibit several quantitative traits: the average adult male body weight ranges from 1.4 to 1.6 kg, while adult females weigh between 1.3 and 1.5 kg. They reach sexual maturity between 18 to 20 weeks, with an impressive egg production capacity of up to 287 eggs per year and a hatchability rate of 75-80%.When male Mojomaster-1 Agrinak ducks are crossed with female Alabimaster-Agrinak ducks, they produce superior Master hybrid ducks that possess several advantages. These hybrids are noted for their relatively high egg production rate of approximately 74% per year, early onset of laying eggs at around 18-20 weeks, and the ability to visually distinguish between male and female day-old ducklings (auto sexing) [47].

Table 4. Production performance of Mojomaster-1 Agrinak ducks

No.	Performance	Score
1	Henday egg production (%)	60 - 70
2	Peak production (%)	78 - 85
3	Egg production/year (grains/%)	250/ 68,5
4	Feed consumption (g/head/day)	160 - 180
5	Age at first egg laying (weeks)	22 - 24
6	Egg weight (g)	53 - 60
7	Feed conversion (average/year 3.5)	3,0 - 4,0
8	Mortality up to 6 weeks (%)	5 - 10
9	Mortality at production age (%)	< 3
10	First brood weight (kg)	1,5 - 1,7
11	First egg weight (g)	50 - 55
12	Fertility (%)	80 - 85
13	Hatchability (%)	85%
14	DOD weight (g)	40 - 45
15	4 week body weight of male (g)	250 – 350
16	4 week female body weight (g)	265 - 300
17	8 week male body weight (g)	1.100 - 1.300
18	8 week female body weight (g)	1.000 - 1.100
19	12 week male body weight (g)	1.300 - 1.500
20	12 weeks female body weight (g)	1.100 - 1.400
21	Body weight 16 weeks male (g)	1.500 - 1.600
22	16 week female body weight (g)	1.400 - 1.500

Source: Prasetyo et al.[44]

CONCLUSION

Indian Runner ducks are domestic ducks that trace their lineage back to the green-headed Mallard wild duck. These ducks exhibit significant phenotypic and genotypic variation, making them suitable for various selection purposes. Notably, selection programs aimed at enhancing egg production have successfully produced strains such as Mojomaster-Agrinak and Alabimaster-Agrinak ducks. By crossing male Mojomaster-Agrinak ducks with female Alabimaster-Agrinak ducks, breeders can create hybrid Master ducks that possess the advantageous trait of auto sexing, allowing for easy differentiation between males and females at a young age. This genetic diversity and the resulting selection programs underscore the potential of Indian Runner ducks in poultry production, particularly in terms of their prolific egg-laying capabilities.

CONFLICT OF INTEREST

There is no conflict of interest in the publication of this article.

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