Qualitative Traits of Local Bambu Apus Rabbits

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ABSTRAK

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Kelinci lokal Bambu Apus merupakan kelinci persilangan yang memiliki sifat kualitatif yang beragam. Banyak diantaranya menyerupai kelinci Rex dan New Zealand White. Sehingga perlu dilakukan perbandingan sifat kualitatif kelinci lokal Bambu Apus dengan kelinci Rex dan kelinci New Zealand White. Total sampel yang diamati sebanyak 94 ekor kelinci lokal Bambu Apus, 89 ekor kelinci Rex, dan 89 ekor kelinci New Zealand White. Penelitian ini bertujuan untuk mengevaluasi sifat kualitatif kelinci lokal Bambu Apus sebagai kelinci yang telah mampu beradaptasi dengan lingkungan DKI Jakarta sehingga diharapkan dapat menjadi galur kelinci pedaging untuk mendukung urban farming di DKI Jakarta. Variabel yang diamati meliputi sifat-sifat kualitatif seperti tipe kepala, tipe telinga, warna mata, warna tubuh dominan, pola warna tubuh, warna belang, penyebaran belang, karakteristik bulu, tipe tubuh, dan ukuran tubuh. Analisis data dilakukan dengan menggunakan software SAS versi 9.4 dengan prosedur PROC FREQ untuk frekuensi dan persentase masing-masing variabel, kemudian dilakukan analisis Multiple Correspondence Analysis (MCA) antar variabel kategori dengan menggunakan prosedur PROC CORESP. Hasil penelitian menunjukkan kelinci lokal Bambu Apus memiliki sifat kualitatif yang berbeda dengan kelinci Rex dan New Zealand White. Adapun sifat kualitatif yang dapat dijadikan pembeda diantaranya keberadaan warna mata biru dan heterochromia, warna dominan cokelat dan pola warna harlequin yang lebih banyak, adanya variasi tipe tubuh compact, karakteristik bulu lion, dan tipe telinga lop. Kelinci lokal Bambu Apus memiliki tipe tubuh komersial dan ukuran medium, menunjukkan potensi genetik sebagai kelinci pedaging adaptif iklim tropis untuk mendukung urban farming di DKI Jakarta.

Kata Kunci: Adaptabilitas, Kelinci Bambu Apus, Kelinci Pedaging, Sifat Kualitatif

ABSTRACT

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The local Bambu Apus rabbit is crossbred with diverse qualitative traits, many resembling Rex and New Zealand White rabbits. Hence, it is necessary to compare the qualitative traits of local Bambu Apus rabbits with Rex and New Zealand White rabbits. The total samples observed were 94 local Bambu Apus rabbits, 89 Rex rabbits, and 89 New Zealand White rabbits. This study aims to evaluate the qualitative traits of local Bambu Apus rabbits as rabbits that have adapted to the environment of DKI Jakarta, so they are expected to become broiler rabbit strains that support urban farming in DKI Jakarta. Variables observed included qualitative traits such as head type, ear type, eye color, predominant body color, body color pattern, stripe color, stripe distribution, fur characteristics, body type, and body size. Qualitative traits observed included head type, ear type, eye color, body color, color pattern, stripe characteristics, fur type, body type, and size. Data were analyzed using SAS 9.4 with PROC FREQ for frequency and percentage of each variable and Multiple Correspondence Analysis (MCA) using PROC CORESP. Results showed that Bambu Apus rabbits exhibit distinct traits, including the presence of blue and heterochromia eye color, predominantly light brown color and harlequin color pattern that is more prevalent in Bambu Apus rabbits, variations in compact body type, lion fur characteristics, and lop ear type. With a commercial body type and medium size, these traits highlight their genetic potential as tropical climate-adaptive broiler rabbits supporting urban farming in DKI Jakarta.

Key Words: Adaptability, Bambu Apus Rabbit, Broiler Rabbit, Qualitative Traits

INTRODUCTION

In late 2003 and early 2004, an avian influenza (AI) outbreak caused by the H5N1 virus spread rapidly in Southeast Asia, including Indonesia. In Indonesia, the AI virus spread very quickly to all parts of Indonesia, including DKI Jakarta. The rapid spread of the disease prompted the government to take precautionary measures to reduce casualties and limit the spread (Sarah 2019; Kencana et al. 2021). As an effort by the DKI Jakarta government to prevent and mitigate AI outbreaks, a policy was issued in Regional Regulation

No. 4/2007 that regulates the Control of Poultry Rearing and Distribution, where people are not allowed to keep poultry freely to prevent AI outbreaks. With the enactment of this regulation, the DKI Jakarta urban farming program also adjusted the livestock commodities that can be developed.

Rabbits are a potential livestock commodity that can be used to produce meat. However, not only meat, fur, and skin can also be utilized, which makes it a livestock with high economic value. As stated by (Brahmantiyo et al. 2014), commercially produced rabbits are very profitable because they can produce quality meat with low production costs. Rabbits have a high growth rate, efficient feed consumption, do not require large areas of land, and a short cultivation process where if adequately maintained (Fischer et al. 2012; Tembachako and Mrema 2016; Jiang et al. 2020; Marín-García et al. 2021). A total litter averaging 40-60 kits per year is produced by a rabbit (approximately 8-12 kits/parity). Another advantage is that the doe can mate immediately after kindling or some days later because of high receptivity at this particular period (Dalle Zotte 2014).

Since October 2020, the Bambu Apus Rabbit Park has been opened under the Services Centre for Animal Health and Livestock (Pusyankeswannak). The Bambu Apus livestock park is devoted to raising livestock in the form of rabbits. Rabbits can be introduced as prospective and alternative livestock for the people of DKI Jakarta who want to participate in supporting the sustainable integrated urban farming program (Margatama et al., 2023). The Service Centre for Animal Health and Livestock (Pusyankeswannak) plans to develop new strains of local Bambu Apus rabbits that are adaptable to the environment and climate of Jakarta by paying attention to breeding according to GFP (good farming practice) and GBP (good breeding practice). Breeding of local Bambu Apus rabbits in Pusyankeswannak is expected to be carried out sustainably, and adequately as a source of animal protein hope from broiler rabbits whose growth is expected to continue to increase in line with the DKI Jakarta Urban Agriculture Grand Design Target in 2030, there are 1.000 rabbits spread and maintained in the community.

Apart from the advantages of rabbit farming, there is a challenge, particularly in that rabbits have an ideal temperature range of around 15-25ºC (Liu et al. 2022). When heat stress occurs, they will attempt to reduce the excess heat through different mechanisms, such as thermoregulatory responses. These responses impact rabbits by interfering with their physiological processes (Mutwedu et al. 2021; El Sabry et al. 2021; Liang et al. 2022). The DKI Jakarta area has an average temperature of 28.8ºC with the maximum temperature reaching 35ºC (Badan Pusat Statistik 2021). Even though it is reared in an unsuitable environment, the local Bambu Apus rabbits can grow and reproduce. Local Bambu Apus rabbits were raised in 2018 in the field owned by the livestock business and promotion unit before establishing the Bambu Apus Rabbit Park in 2020. Pusyankeswannak received 85 rabbits, 75 ready-for-breeding New Zealand White does, and 10 Flemish Giant bucks. The rabbits were then bred, and their offspring have been distributed across five administrative cities in DKI Jakarta. The total population is 109 local rabbits in the Bambu Apus Rabbit Park as of May 2024; this shows the local Bambu Apus rabbit's adaptability to the environment of DKI Jakarta, as evidenced by its population, which still reproduces and survives today.

A strain is a group of individual animals in a breed with specific characteristics used for breeding or cultivation purposes (Setiadi 2017). One of the requirements for the concession of strains stipulated in Article 6 of Permentan Number: 117/Permentan/SR.120/10/2014 is that the characteristics referred to are qualitative traits covering the characteristics of a strain that can be distinguished from other strains. Local Bambu Apus rabbits have diverse qualitative traits, and many resemble Rex and New Zealand White rabbits, requiring further research. New Zealand White rabbits are bred for their meat, and Rex rabbits are bred for their fur and meat. Both breeds can be utilized as broiler rabbits. Therefore, the characterization of qualitative traits of local Bambu Apus rabbits is needed as a basis for the concession of rabbits specific to DKI Jakarta, whose utilization is as broiler rabbits adaptable to the environment of DKI Jakarta.

MATERIALS AND METHODS

This research was conducted at Bambu Apus Rabbit Park, Service Center for Animal Health and Animal Husbandry (Pusyankeswannak) DKI Jakarta, and Poultry and Miscellaneous. Livestock Instrument Standard Testing Centre (BPSI-UAT Ciawi). All work procedures in this study have met the Ethical Clearance standards of the Balitbangtan Animal Welfare Commission (KKHB) of the Agricultural Research and Development Agency, with registration number: Balitbangtan/Livestock Research Centre BRIN/NRm/01/2022.

Sample and materials

For comparison, this study used 94 local Bambu Apus rabbits from Bambu Apus Rabbit Park, 89 Rex rabbits (Rexsi Agrinak), and 89 New Zealand White rabbits from BPSI-UAT Ciawi. The rabbits' age and sex were not considered. The equipment used in this study included a digital thermo-hygrometer, digital scales, a vernier caliper, measuring tape, a posing table, and a posing mat.

Figure 1. Body type of rabbit as (a) Arch, (b) Semi Arch, (c) Compact, (d) Commercial, (e) Cylindrical (ARBA 2000)

Qualitative traits data measurement

Qualitative data measurement is done by direct observation of the rabbit. Qualitative traits variables observed were: (1) Predominant body colour, determined by looking at the colour that dominates throughout the rabbit's body; (2) Body colour pattern, categorised by the number of colour variations on the rabbit's body; (3) Striped colour, determined by colour variations other than the predominant colour on the rabbit's body; (4) The spread of stripes, determined by the extent of the spread of stripes on the predominant colour of the rabbit's body; (5) Fur characteristics, categorised if the rabbit has hair with short size and smooth texture then the rabbit has normal fur characteristics, if the rabbit has hair with short size and upright right on the skin and smooth hair texture then the rabbit has rex fur type, if the rabbit has long, thin and smooth hair then the rabbit has angora fur characteristics, if the rabbit has long hair on the neck and groin then the rabbit has lion fur characteristics, if the rabbit has hair with a smaller diameter and the outer layer is transparent, shiny and slippery then the rabbit has satin fur characteristics (Brahmantiyo et al. 2021); (6) Eye colour, determined by the colour of the iris; (7) Ear shape, determined by the shape of the ears standing upright/lop, if only one ear is lop-shaped it is categorised as standing upright ears; (8) Body type, seen from the shape of the body when in a stationary position, calm and the rabbit's body is on a flat medium. Figure 1 shows the 5 body types of rabbits: (9) Head type, determined based on the index value. The head shape is oval if the head index value is <0.5. If the head index value is >0.5, then the head shape is round (Brahmantiyo et al. 2021); (10) Body size, categorized by weight. If the weight is <2.7 kg, it is categorized as small. If the weight is 2.7-4.1 kg, it is categorized as medium size; if the weight is 4.1-5 kg, it is categorized as large; if the weight is >5 kg, it is categorized as giant size.

The qualitative traits observed were recorded as (1) Predominant body color, 1= White, 2= Light brown, 3= Dark brown, 4= Grey, 5= Black; (2) Body color pattern, 1= One color, 2= Two color mix, 3= Three color mix; (3) Stripe color, 0= None, 1= White, 2= Light brown, 3= Dark brown, 4= Grey, 5= Black, 6= Harlequin; (4) Stripe distribution, 0= 0%, 1= 1 - 10%, 2= >10 - 20%, 3= >20 - 30%, 4= >30 - 40%, 5= >40 - 50%; (5) Fur characteristics, 1= Normal, 2= Rex, 3= Satin, 4= Lion, 5= Anggora; (6) Eye color, 1= Black, 2= Grey, 3= Brown, 4= Pink, 5= Red, 6= Blue, 7= heterochromia; (7) Ear type, 1= Upright, 2= Loop; (8) Body type, 1= Arch, 2= Semi Arch, 3= Compact, 4= Commercial, 5= Cylindrical; (9) Head type, 1= Round, 2= Oval; and (10) Body size, 1= Giant, 2= Large, 3= Medium, 4= Small.

Data analysis

In the data analysis of qualitative traits, the frequency and percentage of each qualitative trait variable were calculated using the PROC FREQ procedure through SAS software version 9.4 to cross-tabulate the qualitative traits observed in different rabbit breeds. Multiple Correspondence Analysis (MCA) between categorical variables was then conducted using the PROC CORESP procedure in SAS software version 9.4. The results will plot the output data in a graphical representation of the relationship between the category variables. The model used in MCA is additive (additional model):

$$\mathrm{Y}_{ij\ldots n} = \bar{\mathrm{Y}} + a_i + b_j + \ldots + \varepsilon_{ij\ldots n} \quad \ldots..\ (1)$$

where $Y_{ij\ldots.n}$ is Observation scores for individuals in the i-th category of variable a, the j-th category of variable b, and so on; $\bar{\mathrm{Y}}$ is grand mean (overall average) of the dependent variable; a_i is influence or effect of the grand mean of the i-th category of variable a; b_j is influence or effect of the grand mean of the j-th category of variable b; and $\varepsilon_{ij\ldots n}$ is residual for the individual corresponding to $\mathrm{Y}_{ij\ldots n}$, where

$$\bar{\mathrm{Y}} = \frac{\sum_{k=1}^{n} Y_k}{n} \quad \ldots..\ (2)$$

with $Y_k$is x-th, the individual's value is the dependent variable, and n is the number of observations.

RESULTS AND DISCUSSION

General conditions of the research site

Local Bambu Apus rabbits were raised at the Bambu Apus Rabbit Park, DKI Jakarta. The Rex and New Zealand White rabbits used in this study were raised at the Poultry and Miscellaneous Animal Instrument Standard Testing Centre, Ciawi. Table 1 presents the average temperatures, humidity, and THI of both locations.

Table 1. Daily temperature and humidity averages and THI values at Bambu Apus Rabbit Park, DKI Jakarta, and Poultry and Miscellaneous Animal Instrument Standard Testing Centre, Ciawi

Location	Temperature (ºC)	Humidity (%)	THI
Bambu Apus Rabbit Park, DKI Jakarta	30.99±4.95	60.30±23.02	28.63±3.30
Poultry and Miscellaneous Animal Instrument Standard Testing Centre, Ciawi	28.07±2.62	80.67±17.86	27.19±2.23

Bambu Apus Rabbit Park in DKI Jakarta has higher temperatures and lower humidity than the Poultry and Miscellaneous Animal Instrument Standard Testing Centre in Ciawi. The THI index at Bambu Apus Rabbit Park in Jakarta is higher than at the Poultry and Miscellaneous Animal Instrument Standard Testing Centre in Ciawi. According to (Sugiono et al. 2016), the temperature relative humidity index (THI) is a numerical representation of the combined impact of air temperature and humidity on the degree of heat stress.

The correspondence between THI values and heat stress categories has been defined by (LPHSI 1990) whereby THI is classified as follows: 27.8= No heat stress; 27.8-28.9= Slight heat stress; 29.0-30.0= Moderate heat stress; >30.0= Severe heat stress. According to the provisions of (LPHSI 1990), Ciawi Poultry and Miscellaneous Animal Instrument Standard Testing Centre is within slight or no heat stress conditions, while conditions in Bambu Apus Rabbit Park may potentially result in moderate heat stress.

In tropical and subtropical areas with high environmental temperatures, livestock animals like rabbits experience heat stress. Because of their thick fur coats and dysfunctional sweat glands, which inhibit their ability to eliminate excess body heat, rabbits are susceptible to heat stress at exceptionally high temperatures (Fadare 2015; Verga et al. 2007). When heat stress occurs, they will attempt to reduce the excess heat through different mechanisms, such as thermoregulatory responses. These responses impact rabbits by interfering with their physiological processes and behavior (Mutwedu et al. 2021; El Sabry et al. 2021; Liang et al. 2022). Increased rectal temperature, decreased feed intake and daily gain, and increased water consumption in meat rabbits are physiological indicators of heat stress that can lead to higher energy consumption and reduced production and reproductive performance (Liu et al. 2022).

Qualitative traits in Bambu Apus rabbits

Qualitative traits of local Bambu Apus rabbits are divided into head, body, and color and fur characteristics. Table 2 presents the results of observations of head characteristics.

Observations of the head characteristics of local Bambu Apus rabbits had the most significant proportion of oval head types at 94.7%. In comparison, round head types were also found in a smaller percentage at 5.3%. The round head and oval head of local Bambu Apus rabbits can be seen in Figure 2. The rounded head type exhibits the "brachycephaly" trait, which is characterized by a reduced facial region of the head. This phenotype can also be considered pathological (Geiger et al. 2021). Indeed, brachycephaly has been described to occur in many domesticated animals (Herre & Röhrs 1990).). In anthropology, brachycephaly was used to define the shape of the cranial vault in dorsal view, based on the measurements of the length and width (Retzius 1850; Rosenberg 1966; Lüps 1974). Domesticated ancient rabbit breeds are known to have short-faced brachycephalic, including the Polish Netherland Dwarf, Dwarf Fox, and Dwarf Rex.

Nevertheless, none of the reviewed studies use the term "brachycephalic" for Dwarf rabbits. However, none of the studies mentioned the term "brachycephalic" in describing Dwarf rabbits (Geiger et al. 2021). Figure 3 shows the jaw structure of animals with brachycephaly.

However, an oversized lower jaw can only be seen in certain strains, varieties, and breeds of rabbits, as this is a malformation that leads to dental malocclusion and an improper arrangement of teeth and jaws (Geiger et al., 2021). Another factor contributing to malocclusion is the limited available space in the oral cavity for growth tooth growth, which is packed. This condition is relatively common in rabbits with rounded head shapes, particularly in lop and dwarf rabbits. The health condition of rabbits that suffer from dental malocclusion will certainly affect their productivity because it will influence feed intake.

Another indicator of head characteristics is ear type. In general, ear types in rabbits are divided into upright ears and lop ears. Most of the local Bambu Apus rabbit population has an upright ear type, 84%, and 16% have a lop ear type. Figure 3 shows the ear types in local Bambu Apus rabbits. The large percentage of upright ears in local Bambu Apus rabbits is thought to be related to the primarily upright-eared parents. Compared to body weight, which develops more slowly, ear length is the body component that matures sooner and achieves its maximum development rate far faster (Dunlop & Hammond 1937). Rabbit breeds, in general, have a strong correlation between ear length and overall

Table 2. Head characteristics of local Bambu Apus rabbits

Variables	Percentage (%)		
	Local Bambu Apus	Rex	New Zealand White
Head type			
Oval	94.7[a]	100[b]	100[c]
Round	5.3	0	0
Ear type			
Upright	84[a]	100[b]	100[c]
Lop	16	0	0
Eye color			
Black	0	0	0
Brown	62.8[a]	78,7[b]	0
Pink	25.5	0	100[c]
Blue	6.4	0	0
Red	2.1	11,2	0
Grey	1.1	10,1	0
Heterochromia	1.1	0	0

Superscripts in different rows indicate the predominant character for each indicator. (a) for local Bambu Apus, (b) for Rex, (c) for NZW

(a) (b)

Figure 2. Ear types in local Bambu Apus Rabbit. (a) Round head type, (b) Oval head type

body size; this is also the case in lop-eared rabbits; however, in pure lop-eared rabbits, gene mutations result in ear lengths that are almost twice as long as in common rabbits of equivalent body size (Castle & Reed 1936). Rabbits use their respiratory rate and ear surfaces as the primary means of heat release, followed by body position because the rabbit has thick insulator hair on their skin, preventing them from losing heat through their skin (Oladimeji et al. 2022). The upright ear type in local Bambu Apus rabbits indicates that the physiological condition of the rabbit's body has adapted to the higher temperature environment of Jakarta. The rabbit ear pinna

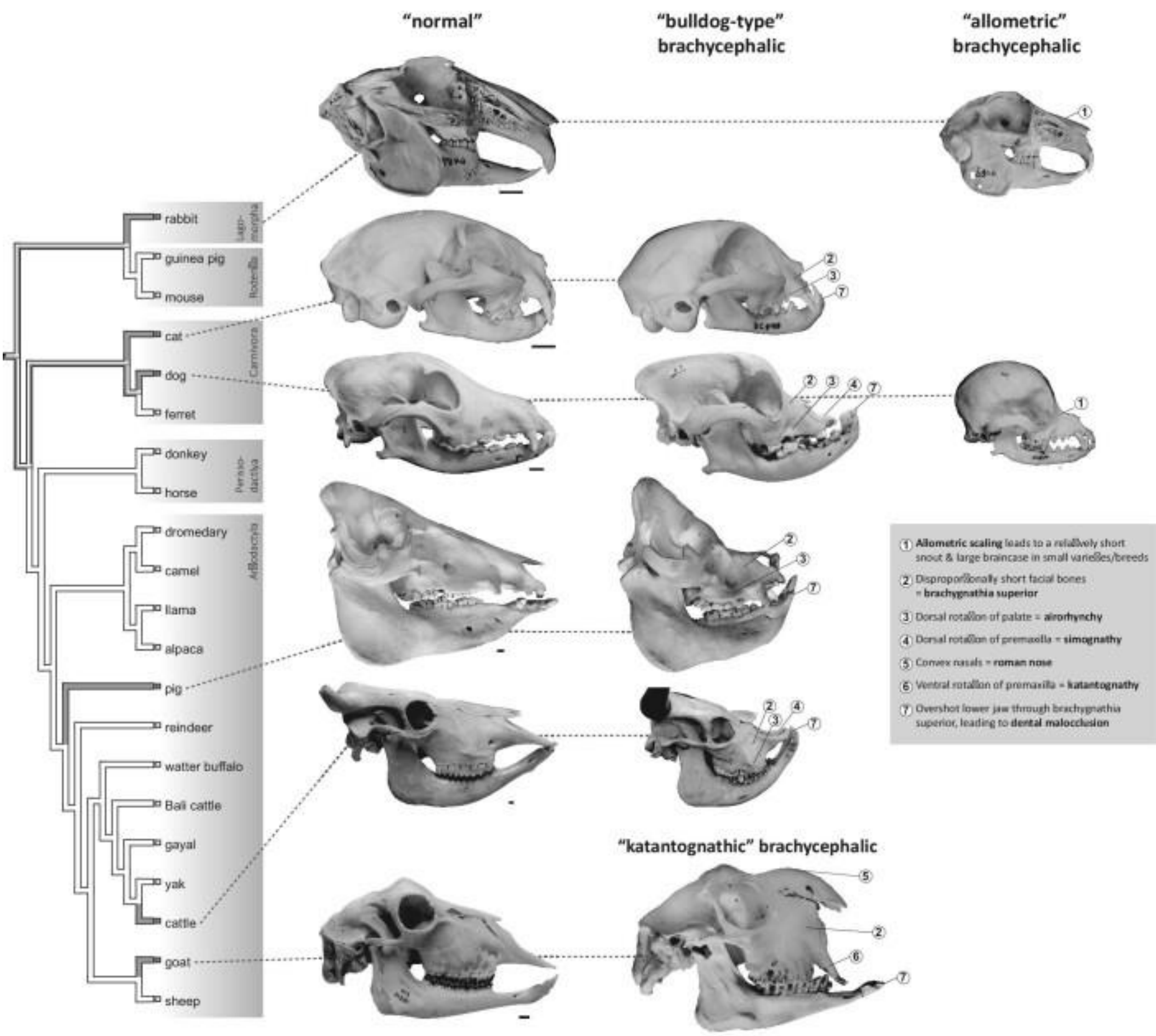


Figure 3. An overview of the different types of brachycephalic in domesticated mammals (Geiger et al. 2021)

(a) (b)

Figure 4. Ear types in local Bambu Apus Rabbit. (a) Lop ear type, (b) Upright ear type

(a) (b) (c) (d) (e) (f)

Figure 5. Eye color in local Bambu Apus Rabbit. (a) Heterochromia, (b) Grey, (c) Pink, (d) Blue, (e) Brown, (f) Red

also has hairless skin that acts as a heat exchanger between the body and the environment and thus plays a significant role in body temperature regulation by changing blood flow to the skin (cutaneous) vascular bed during physiological responses such as warm- or cold-defence. The blood vessels swell (vasodilatation) when the rabbit is overheated and contract (vasoconstriction) in cold weather, so much so that they are almost invisible in cold weather (Ootsuka & Tanaka 2015; Quesenberry et al. 2021). Through this, rabbits with upright ear types allow maximum heat release compared to those with lop ear types. In some conditions, the central mechanisms of cutaneous blood flow control are inhibited by the signal from another system, including the thermoregulatory and alerting Ootsuka & Tanaka (2015), which can help the rabbit monitor the environment and predators.

Through a study conducted by Johnson & Burn (2019), lop-eared rabbits showed higher rates of stenosis/narrowing of the ear canal occurrence of cerumen/earwax build-up and erythema/reddish patches on the skin due to dilation of blood vessels and more frequent potential pain responses during ear examinations compared to erect-eared rabbits. There were also statistically significantly more incisor problems, overgrowth of molars, sharpness of molars, spurs on molars, and veterinary dental history in lop-eared rabbits than in upright-eared rabbits. The domesticated wild rabbits have led to the development of at least nine breeds with lop ears, as the characteristics of lop ears are hereditary (Castle & Reed 1936; British Rabbit Council 2021). Lop-eared breeds have 3-5 mm of soft tissue at the proximal acoustic meatus cartilage ring and distal ear canal tragus cartilage, leading to the formation of the 'pinnae' becoming pendulous (Csomos et al. 2016; Harcourt-Brown et al. 2013).

The color of the iris determines eye color. The iris is composed of two anatomical layers that contain pigments. The sphincter muscle fibers are located near the pupillary margin and are slightly anterior to the pigmented epithelium of the iris. It surrounds the iris's center and narrows the pupil in high light through pupillary light reflex or while adjusting focus. The iris regulates the quantity of light reaching the retina by adjusting the pupil size (Lui & Stokkermans 2023; Bloom et al. 2023).

The eye color found in local Bambu Apus rabbits shows a lot of variation, ranging from brown to heterochromia, where there is more than one variant of eye color in one individual, as seen in Figure 5. Eye color is an expression of the rabbit genotype. Melanocyte and melanosome pigment quantity and distribution inside the iris define the color of the eye (Brahmantiyo et al. 2021). The many eye variations in local Bambu Apus rabbits can be attributed to uncontrolled breeding. However, the most significant percentage of eye color was brown at 62.8%, followed by pink at 25.5%. According to research results by Andriansyah (2023) and Awalia et al. (2016), this is due to inherited traits from both parents, Rex rabbits and New Zealand White rabbits. Rex rabbits have predominantly dark or brown eye color in 90% of the population studied, while New Zealand White rabbits have pink eye color and plain white bodies. Referring to Lukefahr et al. (2022), pink eyes in plain white rabbits express the cc gene that causes albino on the body surface and pink eyes.

A study by Ioshimoto et al. (2018) also revealed that albino rabbits are more sensitive to the retina than rabbits with colored eyes; this is revealed by the ERG of pink-eyed albino rabbits, where the amplitudes are higher under scotopic conditions and more so under photopic and blinking conditions. The more significant receptoral and post-receptoral activity can be accounted for by light gain from scattering and reflections on the layers of the retina. However, a larger ERG is an unfavorable sign that shows worse visual health than usual. The operational and clinical means also reveal an inverse correlation between the depth of color depigmentation and visual acuity. Amblyopia, nystagmus, refractive errors, and foveal hypoplasia cause these effects.

The albino condition, which has poorer vision than pigmented rabbits, will significantly impact the survival and productivity of rabbits living in the wild; this relates to predators' survival mechanisms and finding food. However, this will have little impact on farmed rabbits, as rabbits will be kept in cages that minimize the threat of predators and have readily available feed.

Based on the results of the entire population of local Bambu Apus rabbits observed, 77.7% were identified as medium-sized, while 22.3% were identified as small-sized. Body size can describe the ability of rabbits to produce meat, with the majority of the local Bambu Apus rabbit population classified as medium-sized; this indicates that local Bambu Apus rabbits have the potential to be developed as broiler rabbits.

Besides size, another indicator of body characteristics is body type. Three body types are found in local Bambu Apus rabbits: commercial, compact, and cylindrical. From the three body types found, most (59.6%) local Bambu Apus rabbits have a commercial body shape. A total of 39.4% of the total population of local Bambu Apus rabbits observed had a compact body type. In addition to commercial and compact body types, 1% of the population had a cylindrical body type. The large

Table 3. Body characteristics of local Bambu Apus rabbits

Variable	Percentage (%)		
	Local Bambu Apus	Rex	NZW
Body size			
Large	0	0	100[c]
Medium	77.7[a]	100[b]	0
Small	22.3	0	0
Body type			
Commercial	59.6[a]	100[b]	100[c]
Compact	39.4	0	0
Cylindrical	1	0	0

Superscripts in different rows indicate the predominant character for each indicator. (a) for local Bambu Apus, (b) for Rex, (c) for NZW

Table 4. Comparison of carcass productivity of local Bambu Apus, New Zealand White rabbits, and Rex rabbits

Variables	Sex	Breeds		
		Local Bambu Apus	New Zealand White	Rex
Slaughter Weight (g)	M	2393.80±237.90	2576.80±316.13	2711.44±232.72
	F	2441.60±209.25	2452.50±300.52	3017.18±257.13
	Avg	2417.70±33.80^{b}	2514.69±87.95^{b}	2864.32± 216.19^{a}
Carcass Weight (g)	M	1251.60±218.15	1295.62±185.34	1408.55±125.72
	F	1326.80±139.16	1285.00±84.25	1544.43±140.33
	Avg	1289.20±53.17^{b}	1290.31±7.51^{b}	1476.49±96.08^{a}
Carcass Percentage (%)	M	52.07±5.12	50.18±2.35	51.95±1.55
	F	54.28±1.56	52.58±2.98	51.19±1.78
	Avg	53.18±1.56	51.38±1.70	51.57±0.57
Total Meat Weight (g)	M	832.20±160.96	980.63±151.93	1102.17±107.50
	F	849.80±77.43	945.00±91.92	1188.69±83.94
	Avg	841.00±12.45^{b}	962.81±25.19^{b}	1145.43±61.18^{a}
Total Bone Weight (g)	M	280.00±24.37	302.50±32.07	334.17±29.12
	F	273.60±32.53	335.00±7.07	353.13±24.96
	Avg	276.80±4.53^{b}	318.75±22.98^{a}	343.65±13.41^{a}
Meat-to-Bone Ratio	M	3.00±0.71	3.26±0.50	3.30±0.17
	F	3.14±0.47	2.82±0.33	3.37±0.19
	Avg	3.08±0.10	3.04±0.30	3.34±0.05

Margatama et al. (2023). M= Male, F= Female, Avg= Average

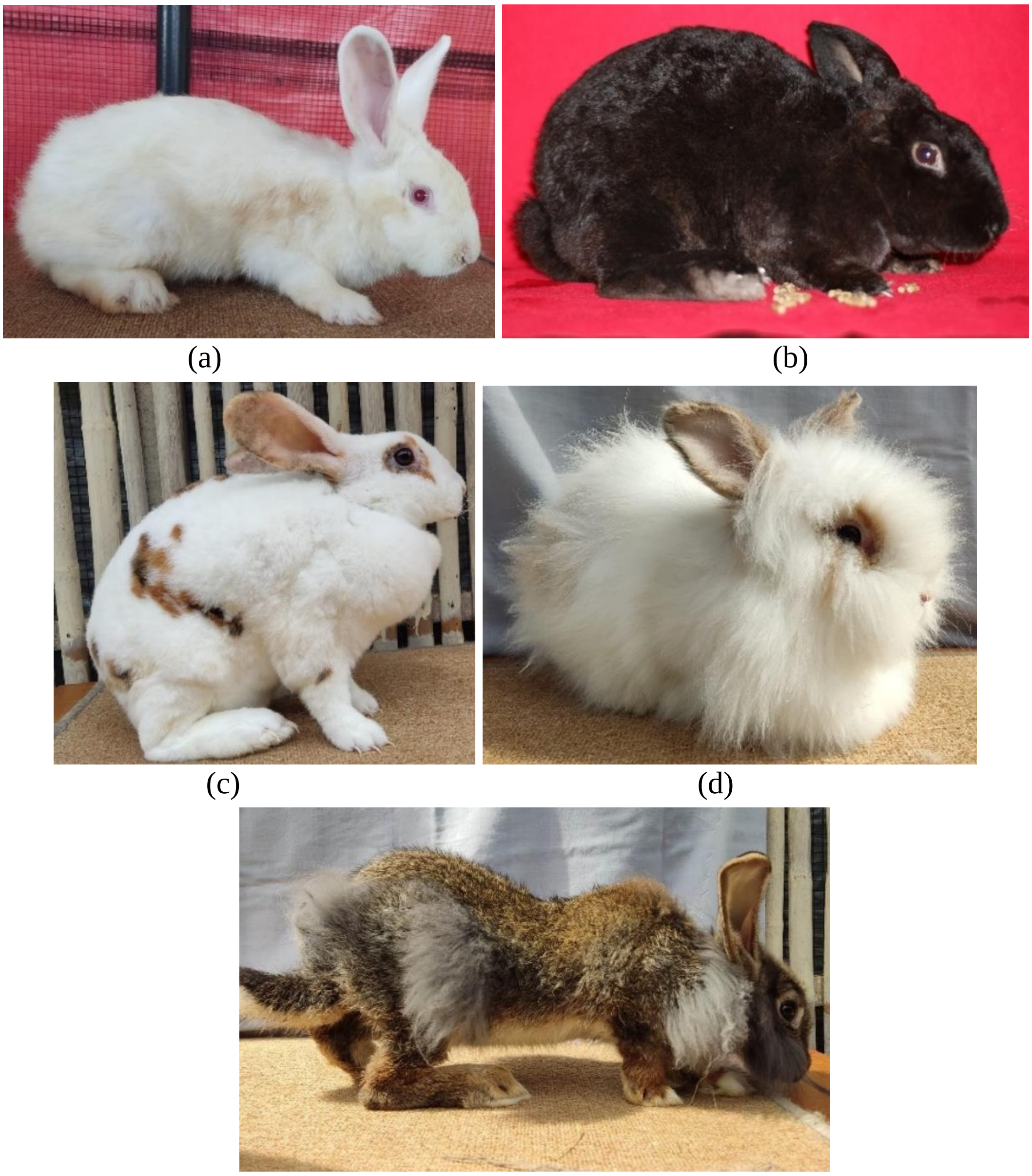
population with a commercial body type is the result of inheritance from the characteristics of the parents of local Bambu Apus rabbits. The compact and cylindrical body types may be influenced by the inherited characteristics of the local Bambu Apus rabbit parents that are not explicitly identified. The weighing of medium-sized local Bambu Apus rabbits and commercial body types in local Bambu Apus rabbits can be seen in Figure 6. Ioshimoto et al. (2018) state that broiler-type rabbits own the commercial body type with a larger and fuller body size. Table 4 compares the carcass productivity of local Bambu Apus rabbits, New Zealand White rabbits, and Rex (rex agrinak) rabbits.

The carcass yield percentage of Local Bambu Apus rabbits is an average of 53.18%, which is not significantly different from the carcass yield of New Zealand White rabbits (51.38%) and Rex rabbits (51.57%). A rabbit carcass is defined as the body part of the rabbit after slaughter, minus the blood, head, skin, feet, tail, digestive tract, and its contents and the contents of the chest cavity (Brahmantiyo et al. 2017). Carcass percentage is a crucial variable in determining the carcass performance of the rabbits produced. The higher the carcass percentage interprets the economic value of rabbit livestock (Wahyono et al. 2021). According to Gillespie (2004), the percentage of good carcasses is 50-59%, so looking at the percentage of carcasses produced by local Bambu Apus has the potential to be used as broiler rabbits. Moreover, the meat-to-bone ratio of local Bambu Apus rabbits (3.08±0.10) is not significantly different from New Zealand rabbits (3.04±0.30) and Rex rabbits (3.34±0.05). The meat-bone ratio is between a rabbit's meat and bone weight (Al-Amin et al., 2020). By comparing the weight of the meat to the weight of the bones, it is possible to determine how much meat is produced compared to the bone (Wibowo et al. 2014).

There are five parameters to indicate color and fur characteristics. The fur colors found were classified into five, as presented in Table 5. The predominant body color (40.4%) of the observed local Bambu Apus rabbit population was white. The pigment melanin is the source of all hair, skin, and eye color in livestock. In mammals, there are two types of melanin: black melanin (eumelanin) and red melanin (phaeomelanin). The colors that appear in livestock combine these two pigments (Caro & Mallarino 2020). Besides one of the known parents is the New Zealand White breeds, the dominance of white color is thought to be a form of adaptation of local Bambu Apus rabbits to the temperature of DKI Jakarta, which has an average temperature of 28.8°C with

(a) (b)

Figure 6. Body traits in local Bambu Apus Rabbit. (a) Medium-sized, (b) Commercial body type



(a) (b) (c) (d) (e)

Figure 7. Fur characteristics in local Bambu Apus Rabbit. (a) Normal, (b) Satin, (c) Rex, (d) Angora, (e) Lion

Table 5. Color and fur characteristics of local Bambu Apus rabbits

Variable	Percentage (%)		
	Local Bambu Apus	Rex	NZW
Predominant body color			
White	40.4[a]	37.1[b]	100[c]
Light brown	12.8	9	0
Dark brown	10.6	10.1	0
Grey	9.6	21.3	0
Black	26.6	22.5	0
Body colour pattern			
1 colour	37.2[a]	37.1[b]	100[c]
2 colours	47.9	57.3	0
3 colours	14.9	5.6	0
Stripe colour			
No stripes	37.2[a]	37.1[b]	100[c]
White	29.8	29.2	0
Light brown	4.26	4.5	0
Dark brown	6.4	5.6	0
Grey	1.1	10.1	0
Black	6.4	7.9	0
Harlequin	14.9	5.6	0
Spread of stripes			
0%	37.2 [a]	37.1[b]	100[c]
1–10%	29.8	9	0
>10–20%	4.3	29.2	0
>20–30%	7.4	11.2	0
>30–40%	6.4	6.7	0
>40–50%	14.9	6.7	0
Fur characteristics			
Normal	72.3[a]	0	100[c]
Lion	16	0	0
Rex	5.3	100[b]	0
Angora	5.3	0	0
Satin	1	0	0

Superscripts in different rows indicate the predominant character for each indicator. (a) for local Bambu Apus, (b) for Rex, (c) for NZW

a maximum temperature reaching 35ºC (Badan Pusat Statistik 2021). Color may affect an animal's body temperature since dark surfaces absorb higher solar energy than bright surfaces, which is then converted to heat (Stuart-Fox et al. 2017).

The predominant color pattern in local Bambu Apus rabbits is two (47.9%), and most (37.2%) do not have stripes. Five characteristics were found while observing local Bambu Apus rabbits: normal fur, lion fur, rex fur, angora fur, and satin fur. Most (72.3%) of the local

Bambu Apus rabbit population had normal fur characteristics. Various fur characteristics of local Bambu Local are shown in Figure 7. Rabbits have different fur types, and the difference between these types is the influence of genotype. Rabbits with long fur are angora, which can produce wool, and Rex rabbits have short, fine hair. Rex rabbits have a unique breed phenotype, which is determined by the minimal presence of the guard and awn hairs that are rather distinguishing from the fur, created from short- and soft-haired coats (Fontanesi 2021). The large variety of fur characteristics in local Bambu Apus rabbits is because they are crossbred from various local Bambu Apus rabbit parents, each with different fur characteristics.

Rabbit breeds correspond with qualitative traits

Local Bambu Apus rabbits have parents from various breeds. Some known parents include New Zealand White and unidentified rabbit breeds. Some local Bambu Apus rabbits show the characteristics of Rex rabbits. Therefore, a correspondence analysis of local Bambu Apus rabbits with Rex rabbits and New Zealand White rabbits was conducted. Correspondence analysis determines the qualitative traits that have a relationship with one of the rabbit breeds and distinguishes between breeds based on the traits of qualitative traits owned by the breed.

The correspondence graph of the rabbit breeds with the qualitative traits in Figure 8 shows that each rabbit breed occupies a different quadrant. Local Bambu Apus rabbits are in quadrant I, New Zealand White rabbits are in quadrant III-IV, and Rex rabbits are in quadrant II. Thus, the three rabbit breeds based on qualitative traits are different and have qualitative characteristics that can be distinguished. The same method conducted by Hayanti et al. (2021) successfully distinguished the district origin of Bali cattle in Jambi Province. Table 6 implements the correspondence graph (Figure 8) of breeds with qualitative traits associated with each breed.

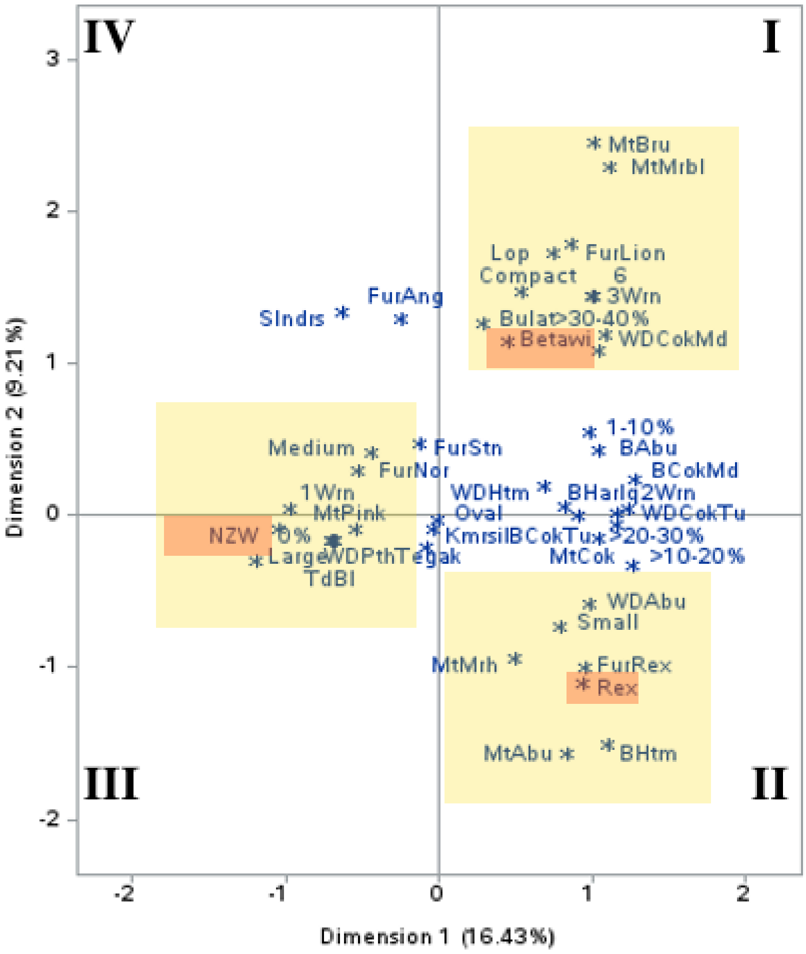


Figure 8. Correspondence graph of rabbit breeds with qualitative traits. Betawi= Local Bambu Apus rabbit, NZW= New Zealand White rabbit, REX= Rex rabbit, Round= Roundhead, Oval= Oval head, Large= Large size, Medium= Medium size, Small= Small size, MtBru= Blue eyes, MtMrb= Heterochromia eyes, MtMrh= Red eyes, MtPink= Pink eyes, WDPth= White predominant colour, WDCokMd= Light brown predominant colour, WDAbu= Ash predominant colour, 1Wrn= 1 colour pattern, 3Wrn= 3 colour pattern, TdBl= No stripes, BHtm= Black stripe colour, BHarlq= Harlequin stripe colour

Table 6. Correspondence graph implementation

Rabbit Breeds		
Local Bambu Apus Rabbit	Rex	New Zealand White
Predominantly light brown color	Predominantly grey colour	Predominantly white color
Blue and heterochromia eye color	Grey and red eye color	Pink eye color
Stripe spread >40-50%	Stripe spread >20–30%	Stripe spread 0%
Harlequin striped color	Black striped color	No striped color
Compact body type	Small size	Large and medium size
Lion fur	Rex fur	Upright ear type
3-color pattern		1 color pattern
Lop ear type		

Table 6 describes the traits that cause the grouping of each breed in different quadrants, as shown in Figure 8. Of the 10 variables of qualitative traits, 8 variables can differentiate local Bambu Apus rabbits from Rex and New Zealand White rabbits. The differentiators include the local Bambu Apus rabbit having a predominant light brown color, the presence of blue and heterochromia eye color, stripe spread >40-50%, harlequin color pattern, and 3-color pattern. As well as fur lion characteristics and lop ear type, which is only seen in the local Bambu Apus rabbit, and the variation of compact body type, which is not found in New Zealand White and Rex rabbits during observation. The local Bambu Apus rabbit is the result of crossing several breeds whose genetic composition is unknown, making it a separate breed different from its parent breeds.

CONCLUSION

Local Bambu Apus rabbits have qualitative traits that differ from New Zealand White and Rex rabbits. Local Bambu Apus rabbits have a predominantly light brown color, variations in blue eye color and heterochromia, stripe spread >40-50%, 3-color pattern as well as harlequin stripe color, variations in commercial body type, fur lion, and lop ears. Genetically, local Bambu Apus rabbits also show potential to develop as broiler rabbits that are adaptable to the environment of DKI Jakarta; this can be shown through the medium size and commercial body type of local Bambu Apus and carcass yield percentage, which is not significantly different from New Zealand White and Rex rabbits as broiler rabbits. Regarding qualitative traits and genetic potential, local Bambu Apus rabbits meet the basic requirements for concession strain broiler rabbits to support the urban farming program in DKI Jakarta.

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