



Phenotypic Similarities and Differences of Genetic Characteristic Boer and PE Goat Yield Crossbreeding 1st and 2nd Generation

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Abstract

This research aimed to analyze the phenotypic similarity and genetic characteristics of 1st and 2nd generation (G1 and G2) goat of Boer and PE goat yield crossbreeding. The number of offsprings of G1 and G2 was 46 and 28 goats, respectively. Data analysis of phenotypic characteristics was estimated by calculating the opportunities of the number of the appearance of G1 and G2 offspring. The result showed that the percentages of the G2 of W1¹ similarity (67.86%) more significant than G1 (26.09%). The W2¹ was the G1 (45.65%) higher than G2 (10.71%), and W3¹ was G1 (28.26%) higher than G2 (21.43%). It concluded that G2 had phenotypic similarities of the characteristic (color) in total progeny. The G2 goat displays the phenotypic characters of inheritance (color) patterns that had more significant similarity than the results of the G1, as well as similarities in morphological characters that were different from the G1. The characteristics (colors) in the G2 had dark brown head color greater than G1, and body conformation approaches to Boer goat. Other colors like light brown, plain white, black, and straight black on G1 greater than G2.

Keywords: Boer goat, PE goat, similarity, phenotypic, heterosis effect.

A. Introduction

Goat is livestock that can produce meat and milk (Goetsch et al., 2011; Maemunah & Isyanto, 2017). One of the Indonesian goats, namely, is Peranakan Etawah (PE) goat. PE goat results from the crossing between Etawah goat (Indian goat) and Kacang goat (Indonesian goat). PE goat is livestock that can adapt to tropical environments and grow well (Rasminati, 2013). PE goat is a hereditary selection of black and white colors. So that the color uniformity eventually occurs evenly (Sumardianto et al., 2013). PE goat has various hair colors (black dominant, white dominant, or brown dominant). Hair color variation is one of the qualitative traits that characterize an animal (Sumardianto et al., 2013). The superiority of PE goat is easy to adapt to the local environment, reasonable reproductive rates, and prophetic (Maemunah & Isyanto, 2017; Rasminati, 2013).

PE goat is spread capable adapt to environmental conditions and its resources minimum, produces functional value as meat and milk-producing (Destomo et al., 2018; Rasminati, 2013). However, the current production of PE goat meat and milk is not optimal. Increasing meat and milk production can be achieved by improving the genetic potential. One way to increase the potential genetic is crossbreeding with the good genetic potential of goat, which high productivity (Ali et al., 2015). One of the goats used as a candidate to increase local goats' genetic potential is the Boer goat (Zhang et al., 2012). Boer goat has the advantage (good endurance) of being able to adapt to extreme environments. Besides, the Boer goat has also gained international recognition with good body performance, fast growth, and good carcass quality.

Crossbreeding is a combination of different individual characteristics, phenotype, and genetic into one cross-breed. Crossbreeding is a method of crossing mixtures in livestock that aims to produce quality livestock. Significantly to increase the productivity of the animals themselves (Azis et al., 2020a; Ryan et al., 2007)—cross-breeding between Boer and PE goat attempts to produce livestock that has inherited qualitative and quantitative traits by their progeny (Ali et al., 2015; Shrestha & Fahmy, 2007). Generally, the results of crossbreeding will have a phenotypic similarity with their progeny. Due to the principle of heredity, there is an equal proportion of inherited 50:50 (male and female). However, another theory states that generally, a substantial proportion of blood is inherited by males (Yilmaz et al., 2010).

Crossbreeding is one way to increase local livestock productivity with other livestock considered to have certain advantages. Crossbreeding is the systematic use of goat genetic resources (goat clumps) by mating planning system to produce specific crossbred progeny (Barry & Godke, 2001; Swalve, 2007). The purpose of crossbreeding is to take advantage of the good qualities of two or more related to distinct types that exist in complementary combinations (Azis et al., 2018; Shrestha & Fahmy, 2007).

Crossbreeding among Boer and PE goat are standard practices developed by the farmer in Indonesia and other countries. Crossbreeding can inherit superior traits possessed by their parent. It is essential to study the first generation and second generation (G1 and G2) and analyze phenotypic similarities and differences of characteristics and estimate the effects of their progeny's heterosis.

B. Methodology

1. Materials of Research

This study has used the result of crossing Boer and Peranakan Etawah (PE) goat, namely the first generation (G1) and the second (G2). The number of materials was 46 (G1) and 28 (G2), respectively.

2. Procedures of Research

Data collection was obtained based on observations in the field directly on the qualitative trait. Qualitative characteristic is phenotypic traits that can be distinguished based on shape and color body of G1 and G2 based on the following characters as below (Table 1, Table 2, and Table 3):

Table 1. Color characteristics of Boer goat as a pure male breed

Code	Color characteristics of Boer
W1	The dark brown of the head to the shoulder, straight white body
	The dark brown of the head to the neck, plain white body, white spot on the head
	The dark brown of the head, white of neck, plain white body, white spot on the head
	The dark brown of the head to the neck, plain white body

Table 2. The characteristic of PE goat as the female breed

Code	The Color of PE Goat
W2	White of head, plain white body
	Blackish brown head, white body
	Brown spotted white head and body
	Black of the head, white spot on head, white body
	Black of the head, tanned white body

Table 3. The characteristic of yield crossbreeding G1 and G2

Code	The Color of G1 and G2
W1 ¹	The dark brown of the head, white body
W3 ¹	plain white body and head, black spot on the head
W2 ¹	White of head, plain brown body
W3 ¹	Plain white of head and body
W1 ¹	Brown of the head, white body
W1 ¹	The dark brown of the head, white body, brown spot on the body
W2 ¹	Light brown head and body, white spot on the body
W1 ¹	Plain dark brown whole body
W2 ¹	Light brown head, black backline
W3 ¹	Blackish brown head, white body
W3 ¹	Blackhead, black-spotted body
W3 ¹	Plain dark black whole body

Information:

W1¹: Boer goat similarity (if 75-100% of body color is dominant of the body's dark brown of head and white color).

W2¹: similarity on Boer and PE goat (if 50-50% of body color is dominant of pale brown of head and white color of the body).

W3¹: similarity on PE goat (if 50-50% of body color is dominant of white and black of the body's head and white color).

3. Parameters of Research

The parameters measured in this study are the color inheritance pattern of W1¹, the Color inheritance pattern of W2¹, the color inheritance pattern of W2¹, and factors that influence crossbreeding goats.

4. Data Analysis

Color characteristics are estimated by calculating the opportunities of number for the appearance of G1 and G2 offspring. The formula for calculating the probability according to (Noor, 2008) is as follows:

$$P(x) = \frac{\sum X_i}{n} \times 100\%$$

Information:

P : Opportunities for the color appearance

X_i : Total appearance of specific colors,

n : Total sample used

C. Result and Discussion

1. The Color Inheritance Pattern of $W1^1$

$W1^1$, $W2^1$, $W3^1$ code could classify the Color Inheritance Pattern of crossing PE and Boer goat. The opportunities of the color distribution on G1 and G2 could be seen in (Table 1). Table 4 shows the phenotypes of G1 and G2 goats, which have $W1^1$ color 26,09% and 67,86%, respectively. The phenotypes of G1 and G2 goats have $W2^1$ 45,65% and 10,71%, respectively. The phenotypes of G1 and G2 goats have $W3^1$ 28,26% and 21,43%, respectively.

Table 4. The Color distribution opportunities of G1 and G2 generation

Code	Phenotype	Size (G1)	Percentage (%)	Size (G2)	Percentage (%)
$W1^1$	Dark brown	12	26,09	19	67,86
$W2^1$	Pale brown	21	45,65	3	10,71
$W3^1$	White/black	11	28,26	6	21,43
Total		46	100	28	100

Based on the $W1^1$ case, it could be assumed that the dark brown color similar to Boer goat more visible in G2 than G1 (Figure 1). Its condition was assumed to be influenced by males' full gene, where the color approach to the male parent. The percentage of the appearance of the color indicates that G2 has the more significant inherited male characteristic. This study's result was in common with research conducted by Yonghong et al. (2001).

Phenotypically, the inheritance pattern related to the body color of the G1 goat looks similar to the Boer goat. However, most G1 goats were not significant in total progeny. It was different from the G2 goat, which has a color similar to Boer goat in total progeny. It was also caused by the dominant gene inherited from one of the parents, where one of the recessive traits of parents.



Figure 1. The color characteristic of G1 and G2 of $W1^1$

Figure 1 shows that the two groups' observations (G1 and G2) were clearer similarities more apparent in male parents. According to (Sponenberg & Bixby, 2007), it is associated with this dark brown color pattern and its resemblance to male elders. The dark brown color is a modification of the expression of eumelanin brown. The dark brown color is an intermediate color between moorit and black caused by a dominant gene (B^bB^b). In a recessive homozygous state (b^bb^b), the color is pale brown, whereas, in heterozygotes (B^bb^b), the color is dark brown (dark brown). Further states that recessive alleles are caused by a gene mutation (Adalsteinsson et al., 1987; Sponenberg & Bixby, 2007). Gene mutations can inhibit the formation of phaeomelanin and eumelanin. Both had color phaeomelanin (brown pigment) and eumelanin (black color) (Nasti & Timares, 2015; and Sponenberg, 1990). Gene mutations can affect phenotypic and genetic traits (Adalsteinsson et al., 1987; Sponenberg & Bixby, 2007; Yonghong et al., 2001). The mutation is a change in genetic material (DNA or RNA) at the gene sequence and chromosome levels. Gene mutation can lead to new alleles and form the basis of new variations in species, especially in phenotypic properties (Destomo et al., 2018; Noor, 2008).

2. Color Inheritance Pattern of $W2^1$

In the $W2^1$ group is a goat that inherits both parents' color by 50% each, so the expression of the color is light brown (Figure 2). The results in Table 4 show that the percentage obtained

by G1 was more significant than G2, 45.65%, 10.75%, respectively. Based on these results, the W2¹ group of G1 influence of Boer goat was not dominant on PE goat. W21 could have the same proportion of blood. The body shape of the W2¹ group resemble PE goat, but the body color was light brown like Boer goat. The brown color characteristic on the head indicated influence by gene activity inherited from his parent.



Figure 2. The color characteristic of G1 and G2 of W2¹

The combination of goat color was thought to occur due to the gene action, which controls the phenotypic trait. The result was conducted by (Inounu et al., 2014). The pattern of head color inheritance of elders to their progeny could be seen based on the basics of head color classification and stripe color on goat's bodies. Roan genes control the combined expression of white hair color into the feather layer without regard to the primary color (Adalsteinsson et al., 1987; Destomo et al., 2018; Sponenberg & Bixby, 2007). This kind of heterozygote condition usually had a mixture of dark and white hair color. Therefore, it looked very pale, white, and brown (Inounu et al., 2014; Noor, 2008).

3. Color Inheritance Pattern of W2¹

The number of opportunities for white head and black and even plain black of the body was more significant than G1 than G2 (Table 4). The white spot, plain white of whole body, black body and striped white, and plain black whole body were identical to PE goat (Figure 3).



Figure 3. The color characteristic of G1 and G2 of W3¹

The gene that controls white colors were thoroughly dominant inherited in G1 and G2. Its color characteristic was the standard color appearance in PE goat. The appearance of white color on the head could be seen in PE goat, and not in Boer goat. The white color and black spot were caused by the Persian gene (Ph^p) at the head pigment locus produced in homozygous conditions (Sponenberg, 1990; Yakubu et al., 2010). Black spot or black dominant due to wild type of gene C⁺, B⁺, E⁺ inherited by a local goat (Adalsteinsson et al., 1987; Sponenberg, 1990). Sponenberg (1990) further explained that spotted color results from a spotted allele at the spotting locus. White spotting was found on the limb and head whose appearance asymmetrical color. The spotted allele was recessive to the primary black color, although 50% in heterozygous condition (black appear) (Noor, 2008; Sponenberg, 1990).

4. Factors That Influence Crossbreeding Goat

Factors that influence the result of the chance of the appearance of colors according to (Hardjosubroto, 1994; Noor, 2008), that qualitative trait is controlled by one or several genes, very little or even totally influenced by an environmental factor (Azis et al., 2020b; 2020c). First-generation of crossbreeding will 50:50 blood proportion inheritance from their parents. The

second or third generation will much greater blood inheritance, around 70-80% (Noor, 2008; Yakubu et al., 2010).

The color characteristic of livestock is considered a character displacement to distinguish livestock from other nation livestock (Warwick et al., 1995). Livestock has primary color, as explained by Noor (2018), is likely black, brown, and white. The colors are expressed through the interaction of at least three pairs of the gene. The colors such as white, brown, black, and pied result from livestock's primary color modification (Yakubu et al., 2010; Zhang et al., 2012). It could explain the diversity in color patterns in livestock (Bowling & Ruvinsky, 2000). The color pattern, such as white patches and spots, are caused by these animals' genetically regulated life processes (Azis et al., 2020a; Bowling & Ruvinsky, 2000; Sponenberg, 1990).

The color patterns in livestock are formed due to pigmentation in the skin, hair, and fur by melanin pigmentation (Nishimura, 2011). The melanin pigments formed colors like red or yellow formed by pheomelanin pigment. At the same time, black or brown are formed by eumelanin pigmentation (Nishimura, 2011; Noor, 2008). The color body dominant or dot with a different color from its parents due to recessive occurrence so that one of the colors (reddish-brown) does not appear. However, its condition underlies the phenotypic changes in each livestock (Yakubu et al., 2010). Black contains two types of homozygous alleles, which the alleles unable to produce brown color in pigmentation. In heterozygotes condition, the alleles can produce black or dark brown (Inounu et al., 2014; Sponenberg, 1990).

D. Conclusion

This study could conclude that G2 had phenotypic similarities of color characteristics in total progeny. G2 goat display phenotypic characters of color inheritance patterns that had more significant similarity than the results of G1 and similarities in morphological characters that are different from G1. The color characteristics in G2 had dark brown head color greater than G1, and body conformation approaches to Boer goat. Other colors like light brown, plain white, black, and straight black on G1 greater than G2.

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