

Phenotypic Characteristics of Local Pigs in the North Sulawesi

Jane S. I. T. Onibala^{1,a}, S. Suyadi², Sucik Maylinda², dan V. M. A. Nurgiartiningsih²

¹Fakultas Peternakan, Universitas Sam Ratulangi, Manado, 95115, Indonesia

²Departemen Produksi Ternak, Fakultas Peternakan, Universitas Brawijaya, Malang, 65145, Indonesia

^aemail: janeonibala_01@gmail.com ; janeonibala@unsrat.ac.id

Abstract

Local pigs are one of Indonesia's livestock germplasm and have an important role in the rural farming system in the North Sulawesi. The aim of this study was to identify the phenotypic characteristic of local pigs in North Sulawesi. The study was carried out as a field-level survey and investigation through direct observation of phenotypic traits of local pigs in eight villages which is located in the two main regions of the North Sulawesi, namely Minahasa Utara (Darunu, Sonsilo, Marinsow, and Kalinaun) and Bolaang Mongondow (Pindolili, Baturapa, Sangtombolang, and Tanjung Sidupa). A total of 212 pigs were used to observe the parameters of body weight, body length, heart girth, height at withers, head length, ear length, and hock circumference. Data were analyzed using a general linear model and discriminant analysis. The results showed that body weight and linear body measurement of local pigs in eight locations in the North Sulawesi were significantly different ($p < 0.05$) with the following traits; average body weight of 27.67 ± 12.90 kg, body length of 70.62 ± 14.21 cm, heart girth of 62.89 ± 13.30 cm, height at withers of 44.73 ± 8.86 cm, head length of 25.06 ± 5.96 cm, ear length of 15.6 ± 4.05 cm and hock circumference of 9.87 ± 1.31 cm.

Keywords: local pigs, body weight, phenotypic

Karakteristik Fenotipik Babi Lokal di Sulawesi Utara

Abstrak

Babi lokal merupakan salah satu plasma nutfah ternak Indonesia dan memiliki peran penting dalam sistem peternakan pedesaan di Sulawesi Utara. Penelitian ini bertujuan untuk mengidentifikasi karakteristik fenotipik babi lokal di Sulawesi Utara. Penelitian dilakukan dengan survei dan investigasi tingkat lapangan melalui pengamatan langsung terhadap sifat fenotipik babi lokal di delapan desa yang berada di dua wilayah utama Sulawesi Utara, yaitu Minahasa Utara (Darunu, Sonsilo, Marinsow, dan Kalinaun) dan Bolaang Mongondow (Pindolili, Baturapa, Sangtombolang, dan Tanjung Sidupa). Sebanyak 212 ekor babi digunakan untuk mengamati parameter bobot badan, panjang badan, lingkar dada, tinggi pundak, panjang kepala dan panjang telinga dan lingkar kaki. Analisis data menggunakan general linear model dan analisis diskriminan. Hasil penelitian menunjukkan bahwa bobot badan dan ukuran linear badan babi lokal di delapan lokasi di Sulawesi Utara berbeda nyata ($p < 0,05$) dengan ciri-ciri sebagai berikut; bobot badan rata-rata $27,67 \pm 12,90$ kg, panjang badan $70,62 \pm 14,21$ cm, lingkar dada $62,89 \pm 13,30$ cm, tinggi pundak $44,73 \pm 8,86$ cm, panjang kepala $25,06 \pm 5,96$ cm, panjang telinga $15,6 \pm 4,05$ cm dan lingkar kaki $9,87 \pm 1,31$ cm.

Kata kunci: Babi lokal, fenotip, bobot badan

Introduction

Local pigs are one of Indonesia's livestock germplasm that has the adaptability to hot climatic conditions, resistant to disease, and able to adapt to fluctuating food conditions. Indonesia is rich in pig germplasm because it has five of the eight species in the world (Rothschild *et al.*, 2011; Soewandi & Talib, 2015).

Local pigs have an important role in the life of the people of the North Sulawesi because apart from being a source of food, they also have quite high economic value. Most of the local pig population in the North Sulawesi is scattered in coastal areas and is kept traditionally or semi-intensively by small

breeders. The North Sulawesi's local pig population currently tends to decline from year to year due to its slow growth rate and many breeders in the North Sulawesi prefer to raise purebred pigs. This threatens the existence of potential genetic resources of local pigs in the North Sulawesi. For this reason, conservation efforts are needed to maintain the genetic resources of local pigs. One of the efforts is to characterize the phenotypic traits of local North Sulawesi pigs.

Phenotypic characteristics or morphometric measures in diversity studies are often used as morphological markers of observable or quantifiable characters. This information is important because it can be used as a basis for

conservation efforts and management. Research on the characteristics of several types of local Indonesian pigs has been carried out, for example, on local pigs in Bali, Atambua, and Toba (Maikameng & Beyleto, 2016; Pasaribu, 2015; Wea & Koni, 2012). However, research on the phenotypic characteristics of local North Sulawesi pigs has not been carried out.

Based on the facts mentioned above, this research was conducted to obtain information about the phenotypic characteristics of local North Sulawesi pigs. It is expected that the results of this research can be taken into consideration by the government in the efforts to preserve and utilize local North Sulawesi pig germplasm.

Materials and Methods

Sampling

This research was conducted in eight locations in North Sulawesi Province (SULUT), namely Darunu, Sonsilo, Marinsow, and Kalinaun which are located in North Minahasa District (MINUT); Pindolili and Baturapa Villages in Bolaang Mongondow Regency (BOLMONG); and the villages of Sangtombolang and Tanjung Sidupa in North Bolaang Mongondow District (BOLMUT).

A total of 212 local pigs (103 males and 109 females) aged over 1 year were used as samples from the villages of Darunu (26 individuals), Sonsilo (23 individuals), Marinsow (23 individuals), Kalinaun (34 individuals), Pindolili (27 individuals), Baturapa (21 individuals), Sangtombolang (25 individuals) and Tanjung Sidupa (25 individuals).

Sampling was done using a simple random sampling procedure that every pig found in the field and easy to handle will be used for the sample. The maximum number of local pig samples was taken according to the conditions in the field. The variables measured were body weight, body length, heart girth, height at withers, head length, ear length and hock circumference according to Food and Agriculture Organization (2012).

Statistical Analysis

General linear model (GLM) and Duncan's multiple range test were performed using SAS Ver. 7.0 (SAS Institute, NC, USA)

was used to analyze the morphometric data of local pigs between locations. Canonical analysis was used to determine the canonical features of local pigs, similarity values and mixed values within and between animals using a procedure PROC CANDISC (SAS version 7.0, SAS Institute, NC, USA).

Results and Discussion

The results on body weight and body measurements of North Sulawesi local pigs are presented in Table 1. Analysis of variance showed there is a significant difference ($p < 0.05$) in body weight and body size, body length, chest circumference, shoulder height, head length, ear length, and the canon circumference of both male and female pigs in the eight research locations (Darunu, Sonsilo, Marinsow, Kalinaun, Pindolili, Baturapa, Sangtombolang and Tanjung Sidupa). From Table 1, it can be seen that local male pigs in the Bolaang Mongondow area, namely Tanjung Sidupa, Sangtombolang, Baturapa and Pindolili) have higher body weights and body sizes compared to local pigs in the North Minahasa area (Darunu, Sonsilo, Marinsow and Kalinaun). The same thing also happened to local female pigs where the body weight and body size of local pigs in MINUT were lower than local pigs in Bolmong. In general, it can be said that the local pigs in the Bolaang Mongondow area have body weights and body sizes that are greater than the local pigs in the Bolaang Mongondow area. The quantitative difference in body size of local pigs between locations/subpopulations is thought to be caused by various factors, including relatively diverse environmental influences including maintenance management, the amount and type of feed which also affects the appearance of body weight and body size between subpopulations. Bolaang Mongondow area is known as a productive area and rich in agricultural products and waste, so the availability of feed is very sufficient. According to Hardjosubroto (1994), genetic and environmental influences, even their interactions, can lead to variations in the observation of various quantitative traits.

Local pigs from different area of North Sulawesi are, undeniably, significantly different based on their phenotypic characteristics tested on this research.

Tabel 1. Average body weight and body measurement of local pigs in the North Sulawesi

Body Measurement Trait	Region	Male			Female		
		\bar{x}	n	CV(%)	\bar{x}	n	CV(%)
Body weight (kg)	Darunu	35.18 ^a ±1.97	14	5.60	32.43 ^a ±3.46	12	10.67
	Sonsilo	37.33 ^{ab} ±2.81	12	7.53	33.79 ^{ab} ±3.45	11	10.21
	Marinsow	39.11 ^b ±3.45	12	8.82	35.31 ^{ab} ±3.99	13	11.30
	Kalinaun	40.35 ^{bc} ±4.28	14	10.61	37.25 ^{bc} ±3.92	20	10.52
	Pindolili	43.98 ^{cd} ±5.98	14	13.60	40.05 ^{cd} ±5.46	13	13.63
	Batu Rapa	44.91 ^d ±6.00	12	13.36	41.20 ^d ±5.53	11	13.42
	Sangtombolang	47.11 ^{de} ±5.80	13	12.31	43.42 ^d ±5.85	12	13.47
	Tanjung Sidupa	50.48 ^e ±5.71	12	11.31	43.69 ^d ±5.38	17	12.31
Body length (cm)	Darunu	77.57 ^a ±6.87	14	8.86	74.08 ^a ±7.50	12	10.12
	Sonsilo	78.83 ^a ±3.54	12	4.49	75.64 ^a ±7.65	11	10.11
	Marinsow	81.67 ^{ab} ±8.61	12	10.54	77.08 ^{ab} ±8.08	13	10.48
	Kalinaun	80.50 ^{ab} ±7.78	14	9.66	80.05 ^{abc} ±9.92	20	12.39
	Pindolili	86.29 ^{bc} ±9.80	14	11.36	83.92 ^{bcd} ±9.27	13	11.05
	Batu Rapa	87.08 ^{bc} ±10.66	12	12.24	84.64 ^{cd} ±7.70	11	9.10
	Sangtombolang	91.46 ^{cd} ±11.64	13	12.73	87.08 ^{cd} ±9.44	12	10.84
	Tanjung Sidupa	95.42 ^d ±6.19	12	6.49	88.53 ^d ±8.91	17	10.06
Heart grith (cm)	Darunu	68.50 ^a ±5.17	14	7.55	66.58 ^a ±7.51	12	11.28
	Sonsilo	70.75 ^{ab} ±5.50	12	7.77	66.27 ^a ±7.06	11	10.65
	Marinsow	72.83 ^{abc} ±8.81	12	12.10	70.31 ^{ab} ±7.24	13	10.30
	Kalinaun	71.14 ^{ab} ±7.58	14	10.66	72.45 ^{ab} ±9.59	20	13.24
	Pindolili	77.07 ^{bcd} ±9.94	14	12.90	75.46 ^{bc} ±9.25	13	12.26
	Batu Rapa	78.50 ^{cd} ±10.94	12	13.94	77.09 ^{bc} ±7.63	11	9.90
	Sangtombolang	81.85 ^d ±9.89	13	12.08	79.75 ^c ±8.53	12	10.70
	Tanjung Sidupa	84.00 ^d ±7.65	12	9.11	80.12 ^c ±8.35	17	10.42
Shoulder height (cm)	Darunu	48.57 ^a ±2.65	14	5.46	47.83 ^{ab} ±3.21	12	6.71
	Sonsilo	48.08 ^a ±4.06	12	8.44	46.91 ^a ±3.83	11	8.16
	Marinsow	50.17 ^a ±4.69	12	9.35	48.15 ^{ab} ±5.37	13	11.15
	Kalinaun	51.50 ^a ±5.11	14	9.92	51.85 ^{bc} ±4.27	20	8.24
	Pindolili	55.43 ^b ±6.27	14	11.31	52.92 ^c ±6.05	13	11.43
	Batu Rapa	56.83 ^{bc} ±4.97	12	8.75	54.82 ^{cd} ±5.71	11	10.42
	Sangtombolang	58.23 ^{bc} ±5.56	13	9.55	57.08 ^d ±4.48	12	7.85
	Tanjung Sidupa	59.75 ^c ±5.21	12	8.72	57.35 ^d ±6.24	17	10.88
Head length (cm)	Darunu	28.07 ^{ab} ±3.50	14	12.47	26.08 ^a ±3.12	12	11.96
	Sonsilo	26.42 ^a ±3.29	12	12.45	26.91 ^{ab} ±1.63	11	6.06
	Marinsow	29.67 ^{bc} ±3.85	12	12.98	27.77 ^{abc} ±2.83	13	10.19
	Kalinaun	30.57 ^{bc} ±3.72	14	12.17	28.65 ^{bcd} ±2.68	20	9.35
	Pindolili	30.93 ^{bc} ±4.01	14	12.96	29.38 ^{cd} ±3.12	13	10.62
	Batu Rapa	30.50 ^{bc} ±3.40	12	11.15	29.00 ^{bcd} ±2.28	11	7.86
	Sangtombolang	31.23 ^c ±3.19	13	10.21	30.33 ^d ±2.35	12	7.75
	Tanjung Sidupa	32.33 ^c ±3.28	12	10.15	30.24 ^d ±3.25	14	10.75
Ear length (cm)	Darunu	17.50 ^a ±1.65	14	9.43	16.75 ^a ±1.76	12	10.51
	Sonsilo	17.33 ^a ±1.23	12	7.10	16.91 ^a ±1.51	11	8.93
	Marinsow	18.92 ^{ab} ±2.23	12	11.79	17.54 ^{ab} ±1.71	13	9.75
	Kalinaun	19.29 ^{bc} ±2.43	14	12.60	18.15 ^{abc} ±2.01	20	11.07
	Pindolili	19.71 ^{bc} ±2.16	14	10.96	18.69 ^{bc} ±2.06	13	11.02
	Batu Rapa	20.08 ^{bc} ±2.15	12	10.71	18.91 ^{bc} ±2.07	11	10.95
	Sangtombolang	20.62 ^{bc} ±2.14	13	10.38	19.42 ^c ±2.23	12	11.48
	Tanjung Sidupa	21.08 ^c ±2.19	12	10.39	19.35 ^c ±2.15	17	11.11
Hock circumference (cm)	Darunu	11.14 ^a ±1.10	14	9.87	10.92 ^a ±1.16	12	10.62
	Sonsilo	11.92 ^{ab} ±1.38	12	11.58	10.73 ^a ±1.27	11	11.84
	Marinsow	11.67 ^{ab} ±1.07	12	9.17	11.00 ^a ±1.08	13	9.82
	Kalinaun	12.57 ^{bc} ±1.09	14	8.67	11.00 ^a ±1.26	20	11.45
	Pindolili	13.79 ^d ±1.19	14	8.63	12.23 ^b ±1.59	13	13.00
	Batu Rapa	13.50 ^{cd} ±1.45	12	10.74	11.91 ^{ab} ±1.45	11	12.17
	Sangtombolang	14.08 ^d ±1.32	13	9.38	12.92 ^b ±1.68	12	13.00
	Tanjung Sidupa	14.50 ^d ±1.17	12	8.07	12.47 ^b ±1.70	17	13.63

*Mean values within a column followed by the different letters are significantly different at $p < 0.05$ according to Duncan's multiple range test.

Table 2. Similarity values and phenotypic mixtures within and between local North Sulawesi pig groups

Region	Batu-rapa	Darunu	Kalinaun	Marinsow	Pindolili	Sang-tombolang	Sonsilo	Tanjung Sidupa	Total
Batu Rapa	23.44	7.81	12.50	4.69	10.94	12.50	15.63	12.50	100.00
Darunu	4.29	20.00	15.71	12.86	14.29	0.00	30.00	2.86	100.00
Kalinaun	8.00	14.67	24.00	13.33	4.00	2.67	17.33	16.00	100.00
Marinsow	7.58	13.64	24.24	21.21	3.03	1.52	25.76	3.03	100.00
Pindolili	25.00	4.17	8.33	8.33	11.11	8.33	19.44	15.28	100.00
Sangtombolang	13.64	6.06	3.03	7.58	9.09	18.18	10.61	31.82	100.00
Sonsilo	8.82	10.29	4.41	16.18	4.41	1.47	48.53	5.88	100.00
Tanjung Sidupa	15.07	8.22	5.48	10.96	5.48	8.22	8.22	38.36	100.00
Total	13.18	10.65	12.27	11.91	7.76	6.50	21.84	15.88	100.00

The differences found in pigs of different regions of North Sulawesi could be due to animal adaptations along years to the surroundings where they are. This animal has changed remarkably since its domestication (Price & Evin, 2019). In this sense, it could be assumed that the local pigs of different region of North Sulawesi retain phenotypic characteristics that suit their environmental conditions where they survive.

A discriminant analysis was carried out with reassignment of two main regions of North Sulawesi: North Minahasa and Bolaang since these sites provided enough samples in order to perform this type of statistical analysis. This type of analysis is used for studying genetic diversity and population structures of organism and for supporting the decision making on conservation strategies (Van Ba *et al.*, 2020). Table 1 show the average of phenotypic characteristics of both male and female pigs which were found among regions.

It was found that body measurements of North Sulawesi local pigs show that body weight and linear body measurement of local pigs in eight locations were significantly different ($p < 0.05$). Average body weight 27.67 ± 12.90 kg, body length 70.62 ± 14.21 cm, heart girth 62.89 ± 13.30 cm, withers height 44.38 ± 8.86 cm, head length 25.06 ± 5.96 cm, ear length 15.6 ± 4.05 cm and hock circumference 10.42 ± 2.31 cm (Table 1).

Cluster analysis based on phenotypic similarity rate (Table 2) showed a clear morphological homogeneity in characteristics of local pigs raised in Sonsilo and Tanjung Sidupa. Local pigs with a high level of similarity in the population mean that the mix of genes from outside populations is likely to be small. The high level of phenotype size similarity in the two locations is thought to be due to their relatively isolated location,

resulting in little chance of mixing with local pigs from other areas. Geographically, Tanjung Sidupa is the most difficult location to reach. Local pigs that have the lowest similarity value are Pindolili (11.11%) and Baturapa (18.18%).

The existence of subpopulations in difference area of North Sulawesi local pigs was evident. These subpopulations corresponded to local pigs raised in the eight studied areas. From morphological point of view, the local pigs raised in Sonsilo were very distant from the others. In contrast, those pigs from region of Sonsilo and Sangtombolang were the isolated from the morphological point of view. Local pigs evaluated in both area mentions above showed morphometric differences, which pointed out to possible of difference in genetic distance, could be examined with specific molecular genetic studies. These differences in morphometric performance appear to be originated in the diverse management systems for every involved area of the present (Huting *et al.*, 2018). It is considered that the existing local pig population raised in North Sulawesi region exhibited homogeneity in terms of adaptation to the environment and managements systems among regions studied of the North Sulawesi.

Most of the similarities in body morphology and morphometry of the pigs between the observed areas in North Sulawesi can occur because of the inter-location gene flow. Gene flow from one area to another can occur either because of the movement of these local pigs or introduction by the community between the observations sites (Wang *et al.*, 2019). Therefore, his study confirms that the morphological similarities in accordance with the results of measurements and observations are very likely due to the existing gene flow between the two populations.

On the other hand, discrepancies in morphometric measurement results were possible due to geographic and regional isolation. These local pigs are practically unrelated to local pigs from other regions. As a result, there are effects such as fragmentation of the region which results in inbreeding among individuals lived in a fragmented population (Cornelius *et al.*, 2017).

This characterization of the morphology of pigs living in the North Sulawesi region is a pioneering work, even from the study of new methods in relation to morphometric studies of local pigs, which otherwise have not been widely used in several previous studies (Santa *et al.*, 2021; Sarajar *et al.*, 2019). Furthermore, this is the first time the traditional pig population at North Sulawesi site has been studied. In this regard, it is interesting to underline that this local pig can be considered as the main protein source for the majority of the population in North Sulawesi. In terms of conserving biological resources, North Sulawesi's local pigs are under permanent genetic erosion pressure. Cornelius *et al.* (2017) mentioned that genetic erosion pressure occurs because of the random crossbreeding with exotic races that are not adapted or by environmental degradation and by human hunting. Therefore, it is imperative to target these resources as animals that are at risk of extinction even before their official recognition.

This research is considered to be the first step in the characterization and conservation of local pigs found in North Sulawesi and is expected to make a scientific and practical contribution to the official recognition of this species of animals that are stressed by the human population. In addition, this research is expected to maintain the existence of important germplasm as biological abundance in North Sulawesi.

Conclusion

The results show that body weight, body length, heart girth, height at withers, head length, ear length, and hock circumference of local pigs in eight locations in North Sulawesi were different. Phenotypic similarities rate showed a clear morphological variety in the characteristics of local pigs raised in North Sulawesi.

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