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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Qualitative Analysis of Non-Feather Distributions as a Phenotype and Genotype in the Indonesian Indigenous Naked Neck Chickens

B. Ariyadi, J.H.P. Sidadolog, S. Harimurti, S. Sudaryati and Wihandoyo
Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta-55281, Indonesia

Abstract: This study was conducted to analyze the relationship between the condition of non-feather distributions and its genetically traits as a multiple allele of the feather condition in the Indonesian indigenous naked neck chickens. Eight males Indonesian naked neck chickens were paired with the five females that had the different condition of non-feathers distribution, namely non-feathers on the neck only (30%); non-feathers on the crop and breast (60%) and non-feathers on the neck, crop, breast and the back of body (90%). Assuming that the non-feathers distribution was caused by a multiple alleles of Na gene and developing of distribution were caused by Na^+ as a multiple alleles of Na gene. This study revealed the effect of multiple allele Na^+ on the distribution of non-feather areas in the chicken bodies. Analysis of inheritance was conducted by Mendelian heredity with chi-square (X^2) analysis. The results, in the Indonesian naked neck chicken, showed that the distribution of non-feathers areas from the neck to the back of body might be caused by genetic of Na^+Na^+ and Na^+Na. The non-feather distribution areas in the crop, breast and the thigh might be genetics effect of Na^+na and NaNa (90%). The non-feather distribution areas in the neck or in the crops might be genetics effect of Nana. The normal feathers of chicken might be effect of recessive gene of nana. Moreover, the study showed that the Indonesian naked neck chicken had a lower productivity, higher embryonic mortality and lower hatchability.

Key words: Indonesian naked neck chickens, production, reproduction ripitabilitas, heritability

INTRODUCTION

Animal germplasm assets in Indonesia including indigenous chicken has a large enough diversity. Almost all rural areas in Indonesia had the indigenous chicken. Indonesian indigenous chickens are animal germplasm assets that are very valuable. One variation, that is often found, is the conditions that do not grow feathers on the neck, which is then referred to as naked neck chicken. The appearance of a genetic trait is controlled by autosomal Na genes that dominant to its allele of na. The appearance of non-feather neck was caused by a gene mutation that took place in the evolution. It is a process of mutation on the many native chicken (Sidadolog *et al*., 1996; Rajkumar *et al*., 2009).

A naked neck is a phenotypic expression controlled by a single dominant of autosomal gene of Na that is characterized by the reduction of chicken feathers in the neck area. It is an incomplete dominant gene, whereas heterozygotes can be identified with feathers on the ventral side of the neck, while homozygotes have no feathers on the neck, crop, back and chest. It reduced feather mass by 20% to the chicken with genotype of Nana, thus it can improve the heat loss. Therefore, chicken with genotype of Na was more tolerant to heat stress compared with the normal feathers (Rajkumar *et al*., 2010).

An organism that has a pair of identical alleles for a trait or character could be said a homozygous genes that regulate these properties. Since a naked neck is an autosomal and incomplete dominant gene; this causes skin redness of naked neck chickens towards sexual maturity. The homozygous NaNa can caused a reduction of about 40% of feathers compared with normal condition. An organism that has a pair of different alleles of gene is said heterozygous gene that regulates the trait. Unlike homozygotes, heterozygotes are not actual heredity because they have gametes with different alleles (Campbell *et al*., 2008; Fathi *et al*., 2013).

In the tropics, chicken farms can suffer the large number of economic losses due to various chickens performance because of the interaction of genotype with the environment. The effects of heat stress on chicken performance can be reduced by using a naked neck gene (Melesse *et al*., 2011). Naked neck chickens can more tolerant to heat stress than the normal feathered chicken because it reduces the mass of feather for optimal heat dissipation. The lower mass of feathers can increase the surface area for heat dissipation effectively and increase heat loss from the neck area. In the tropics, chicken with Na gene has the potential to produce meat higher than normal chickens because of tolerance to heat stress (Rajkumar *et al*., 2011).

Naked neck chicken is a gene that is essential for poultry production in the tropics. This is due to high ability to dispose of body heat, so it promises high productivity under the influence of heavy tropical

Corresponding Author: Bambang Ariyadi, Faculty of Animal Science, Universitas Gadjah Mada, JL Fauna 3, Bulaksumur, Yogyakarta, Postal-55281, Indonesia

environment and more resistant to disease. It can be a superior to normal chicken in terms of growth, egg production, egg and meat quality (Islam and Nishibori, 2009). The positive effects of this genes are known in the producing breast meat (N'dri *et al*., 2007). Hossain *et al*. (2012), revealed that chicken with Na genes can produce breast meat, dark meat ratio and the heart better than the chicken with na genes.

Rajkumar *et al*. (2010), stated that performance of naked neck genotype of NaNa and Nana can be better in some traits because of good heat adaptation. Naked neck genes could be an alternative for producers of poultry, especially in tropical countries where the ambient temperature is very high. Some effects of Na gene in poultry have been investigated, particularly in response to the high temperatures which are important factors that affect the productivity of poultry. Under conditions of heat, chicken with normal feathers cannot rapidly dissipate heat after feeding, it cause a drop in feed consumption and weight gain or egg production (Singh *et al*., 2001). Melesse *et al*. (2011), stated that naked neck chickens and its heredity could be more tolerant of heat stress.

Commercial use of Na alleles is very limited for the moment, due to the high embryo mortality caused by gene of Na, especially in embryos with homozygous genotype. The cause of embryonic mortality because of Na alleles was still unclear. The embryonic mortality of naked neck can be caused by incorrect embryos position by a reduction of feathers on the neck, or metabolic abnormalities (Sharifi *et al*., 2010).

Naked neck chicken of NaNa can reduced feather by about 40% compared with the normal conditions of nana. while naked neck chicken of heterozygous can reduced by about 20-30%. Na genes can affect the availability of feather channels and some birds were completely absent. Naked neck chicken do not have follicles of feather in the head and neck, except around the crest, the anterior spine and two small sections at the top of the crop (Fathi *et al*., 2013). In the tropics, some studies have been carried out on a naked neck chicken genes of Na in the non-race chicken populations. This codominant gene can reduce feather of 20% in heterozygous of Na/na, while in the homozygote can reduce feather of 40% of Na/Na chicken (Cahaner *et al*., 2008).

Na gen can influence on the heat dissipation in terms of influencing appetite. At cold temperatures, it will increase the need of feed to maintain body heat. The specific effect of this gene is associated with increased vitality and can reduce the liver enlargement. Naked neck chicken has better production values, because a decrease of feathers can improve heat tolerance and have better adaptation at high ambient temperatures. Na gene have a deficiency at a low temperature of 20°C or lower ambient temperature, but it has ability at a temperature of 30°C or more in weight gain, feed conversion efficiency, egg production and carcass yield (Islam and Nishibori, 2009).

Sidadolog *et al*. (1996), studied that Indonesian naked neck chicken can produce eggs higher than of the normal feathered chicken. In the high temperatures environments, naked neck chickens had better egg production than of the normal feathered chickens (Yakubu, 2008; Caratachea *et al*., 2010). This study was conducted to analyze the relationship between the condition of non-feather distributions and its genetically feature as a multiple allele of the feather condition in the Indonesian naked neck chickens.

MATERIALS AND METHODS

Experimental birds and research design: Indonesian native naked neck chicken with the age and weight of the relatively uniform were used in this study. Eight males and 40 females with various distribution of non feather were used. The birds were kept in breeding cages with a ratio of 1 male and 5 female to obtain naked neck chicks. The study was began with setting the mating of adult chickens that had a uniform age and weight. All chickens were identified according to non-feather distributions. Mating scheme of Indonesian indigenous naked neck roosters and hens were shown in Table 1.

Data collection: Observation of egg laying in the trap nest were done carefully every day. Egg production of parent was recorded to determine the egg production. Eggs produced from mating were collected and given identification numbers. Egg collections were hatched gradually every week. Candling of eggs were done for 3 times; the 3rd day, the 13th and the 18th day. On the third day of incubation, the infertile eggs as well as death in the early days of hatching were removed. The eggs with embryonic mortality, on the 13th and the 18th day of incubation, were observed for feather conditions. Thus, the feather condition of mating can be known since the development of the embryo. After hatched, the chicks were given an identification number on the wing according to their parents. The chicks were identified based on the condition of feathers and then kept together according to the conditions of their feathers.

Data analysis: Qualitative data analysis was done by comparing variations in the feather condition produced from each mating. The heredity was observed by the distribution of Mendel by comparison of feather condition of the two parents. Data analysis was done with nonparametric statistics of chi square. Quantitative data analysis was done by using analysis of variance or a nested hierarchical pattern design.

RESULTS

Table 2 shows the body weight of Indonesian indigenous naked neck roosters and hens. Table 3

Table 1: Mating scheme of Indonesian indigenous naked neck roosters and hens

	Hens					
Roosters No.	Non-feather conditions[1]	Normal (nana)	30% (Nana)	60% (NaNa;Na$^+$na)	90% (Na$^+$Na$^+$;Na$^+$Na)	Total
1	60%	0	2	2	1	5
2	30%	0	2	2	1	5
3	30%	0	2	2	1	5
4	30%	0	5	0	0	5
5	30%	0	3	2	0	5
6	30%	0	4	2	0	5
7	30%	0	3	2	0	5
8	60%	0	3	2	0	5
Total	8 roosters	0	29	16	3	40 hens

[1] Normal = area of body without feather of 0% (nana),
30% = area of non-feather of 30% (neck only; Nana),
60% = area of non-feather of 60% (neck, chest and thigh; NaNa; Na$^+$na),
90% = area of non-feather of 90% (neck, chest, thigh and back; Na+Na+; Na+Na)

Table 2: Body weight of Indonesian indigenous naked neck roosters and hens

Parents	Genotype	n	Body weight
Roosters	Total	8	2233.50±322.08
	60%	2	2136.50±342.95
	30%	6	2265.83±341.59
Hens	Total	40	1502.78±250.21
	90%	3	1660.67±288.10
	60%	16	1516.88±240.02
	30%	21	1469.48±255.95

shows the egg production, fertility, hatchability and embryonic mortality during the 50-day observation of production. Table 4 shows the average of egg weight and eggs index during the 50-day observation of production.

Table 5 shows the value of genetic heritability of egg weight, weight index and hatching eggs in the Indonesian indigenous naked neck chickens. Table 6 shows the estimation of the distribution of genotypes of the area of non-feather on naked neck chickens. Table 7 shows the distribution of the roosters and females in a mating group based on the area of non-feather on naked neck chickens. Table 8 shows the distribution of chicks based on the area of non-feather on naked neck chickens.

DISCUSSION

We here identify the relationship between the condition of non-feather distributions and its genetically traits as a multiple allele of the feather condition in the Indonesian indigenous naked neck chickens. Significant findings, in the Indonesian indigenous naked neck chickens, were: (1) the distribution of non-feathers areas from the neck to the back of body might be caused by genetic of Na$^+$Na$^+$ and Na$^+$Na, (2) the non-feather distribution areas in the crop, breast and the thigh might be genetics effect of Na$^+$na and NaNa, (3) the non-feather distribution areas in the neck or in the crops might be genetics effect of Nana, (4) the normal feathers of chicken might be effect of recessive gene of nana, (5) the chickens had a lower productivity, higher embryonic mortality and lower hatchability.

Average production of eggs for 50 days of production, in the Indonesian indigenous naked neck chickens, were 24.46±11.38% with a diversity of 46.53%. For each group of mating, average production of eggs were in the range between 14.40±4.98 and 37.20±13.90% and also with a very high diversity between 18.67 to 76.83%. This results showed that the genetic diversity of non-feather area on naked neck chickens might gave a big influence. The average of eggs fertility were 60.96%, while each group was in the range of 43.33 to 75%. This fairly large range might be caused by the diversity of reproductive traits, as well as by the diversity of non-feather area on naked neck chickens. The lower fertility might produced lower hatchability of 49.46% with its fairly large range of 29.73% in the group-eight to 61.11% in group-one. The lower hatchability might be followed by the higher level of embryonic mortality during the hatching. The embryonic mortality were 11.50% with a range in each group between 21.62% in the group-eight and 7.69% in the group-five. Yakubu *et al*. (2008) reported that Nigerian indigenous naked neck chickens had 71.49% hatchability and 28.66% embryonic mortality. Islam and Nishibori (2009) showed that Bangladeshi indigenous naked neck chickens had 16% embryonic mortality. Caratachea *et al*. (2010) reported that Mexican naked neck chickens had 54% egg production and 51.0 g egg weight. Sharifi *et al*. (2010) reported that Na genes might induced embryonic mortality in the naked neck broiler dams.

Egg weight of Indonesian indigenous naked neck chickens ranged from 42.38 to 48.78 g. This egg weight might be relatively large for this type of Indonesian indigenous chickens. The normal egg index of Indonesian indigenous naked neck chickens were between 76.05 and 79.30%. This egg index showed the value of the eggs rather long-oval shape. The difference between hatched-egg weight and the egg weight might be large enough, because the chicks weight were 70%

Table 3: Egg production, fertility, hatchability and embryonic mortality during the 50-day observation of production

Groups	Egg production (%)	Fertility (%)	Hatchability (%)	Embryonic mortality (%)
1	14.40±4.98	75.00	61.11	13.89
2	21.20±11.19	64.15	49.06	15.09
3	24.95±19.17	64.06	53.13	10.94
4	36.98±27.23	43.33	48.33	8.33
5	15.60±8.65	56.41	48.72	7.69
6	37.20±13.90	60.22	49.46	10.75
7	31.60±5.90	60.76	51.90	8.86
8	18.50±7.37	51.35	29.73	21.62
Average	24.46±11.38	60.95	49.46	11.50

Table 4: Average of egg weight and eggs index during the 50-day observation of production

	Groups							
	1	2	3	4	5	6	7	8
Egg weight (g; n = 461)	46.25	43.58	43.70	45.77	42.38	44.56	46.38	48.78
Egg index (%; n = 461)	77.64	77.60	76.66	76.05	79.46	79.30	77.70	77.61
Egg width (cm)	4.00	3.96	3.91	3.91	3.83	3.97	4.01	4.06
Egg length (cm)	5.17	5.11	5.11	5.15	4.83	5.01	5.16	5.24
Hatched-egg weight (n = 226)	32.82	29.65	30.47	31.97	29.26	30.02	31.71	34.36
Hatched-egg/egg weight (%)	70.96	68.04	69.72	69.85	69.04	67.38	68.36	70.44

Table 5: Value of genetic heritability of egg weight, weight index and hatching eggs in the Indonesian indigenous naked neck chickens

Genetic traits	h^2 (♂)	h^2 (♀)	h^2 (♂ + ♀)	$\sigma^2 D$
Egg weight	0.22	1.78	1.00	1.56
Egg index	0.40	0.55	0.48	0.15
Egg width	0.34	0.65	0.50	0.31
Egg length	0.53	1.62	1.08	1.09
Hatched-egg weight	0.51	2.83	1.67	2.32

Table 6: Estimation of the distribution of genotypes of the area of non-feather on naked neck chickens

Genotype	area of non-feather	Score	Interval	%
Na^+Na^+	Neck, crop, chest, Abdomen, thigh, back	4	80-90	90
Na^+Na	Neck, crop, chest, Abdomen, thigh	3	60-80	90
NaNa	Neck, crop, chest	3	50-60	60
Na^+na	Neck, crop	2	40-50	60
Nana	Neck	2	10-30	30
Nana	Normal feather	1	0	0

Table 7: Distribution of the roosters and females in a mating group based on the area of non-feather on naked neck chickens

	Groups							
Chickens	1	2	3	4	5	6	7	8
Roosters	Na^+na	Nana	Nana	Nana	Nana	Nana	Nana	Na^+na
Hen 1	Na^+Na	Na^+Na	Na^+Na	Nana	Nana	Nana	Nana	Nana
Hen 2	Na^+na	NaNa	Na^+na	Na^+na	Na^+na	NaNa	Na^+na	NaNa
Hen 3	Na^+na	Na^+na	Na^+na	Na^+na	NaNa	NaNa	Na^+na	?
Hen 4	Nana	Nana	Nana	Nana	Nana	Nana	Nana	Nana
Hen 5	Nana	Nana	?	Nana	Nana	Nana	Nana	Nana

?: Chickens had no chicks to be identified

from the egg weight with a range between 67.38 to 70.96%. The value of heritability of egg-weight trait were 0.22, this value might be relatively lower compared to hatched-egg weight as 0.51 and egg index of 0.40. This might be under influence of a dominant gene as follows: in the egg weight of 1.56, in the length of the egg of 1.09 and hatching weight of 2.32, in the eggs index of 0.15 and in the width of the eggs of 0.31. Yakubu *et al*. (2008) reported that Nigerian indigenous naked neck chickens had 43.04 g egg weight and 74.68% egg index. Islam and Nishibori (2009) showed that Bangladeshi indigenous naked neck chickens had 39.99 g egg weight and 82.22% egg index.

The differences of non-feather area on naked neck chickens might be a distributive traits that might be a codominant or intermediar traits. The normal-feather chicken might be caused by recessive gene of na and the appearance of area of non-feather on naked neck chickens started from the neck might be caused by a dominant gene of Na. If the Na genes and its allele of na were present in the individual birds of Nana, the non-feather area on naked neck chickens might be in the

Table 8: Distribution of chicks based on the area of non-feather on naked neck chickens

		----- Normal ------		--------- 30% ----------		-------- 60% -------		------ 90% ------		Total
Groups	n	n	%	n	%	n	%	n	%	%
1	27	4	14.81	16	59.26	5	18.52	2	7.41	100
2	34	4	11.76	17	50.00	8	23.53	5	14.71	100
3	40	4	12.20	18	43.90	12	29.27	6	14.63	100
4	34	7	20.59	23	67.65	4	11.76	0	0.00	100
5	22	3	13.64	14	63.64	5	22.73	0	0.00	100
6	56	5	8.93	42	75.00	9	16.07	0	0.00	100
7	48	19	39.58	17	35.42	9	18.75	3	6.25	100
8	19	2	10.53	14	73.68	3	15.79	0	0.00	100
Total	280	48	17.14	161	57.50	55	19.64	16	5.71	100

neck only. In the chicken with homozygous NaNa, deployment of non-feather area on naked neck chickens might extend to the crops and chest. The increasing of non-feather area to the lower part of the body and thigh might be caused by gene of Na^+. It could be assumed that the distribution of non-feather area extended to the back of body, It might be caused by the genotypes of Na^+Na^+. It might reached about 80-90% of non-feathers area. Then, it could be estimated that deployment of non-feather area might be based on their genotypes. It might be vary as follows: 0% for normal-feather chicken, 30% for chicken with non-feathers area on the neck, 60% for chicken with non-feathers area on the neck and the chest, 90% for chicken with non-feathers area extended to the thigh and the back of body.

Conclusions: From the results of phenotype and genetic analysis, it could be drawn some conclusions as follows:

1 The average of egg weight of Indonesian indigenous naked neck chickens were 45.18 g with an index of 77.75%,
2 Embryonic mortality of Indonesian indigenous naked neck chickens during the hatching were 11.50%, caused a decrease in hatchability of 49.46%,
3 Fertility of Indonesian indigenous naked neck chickens were 60% and the egg production for 50-days were 24.46%,
4 The distribution of non-feather area on Indonesian indigenous naked neck chickens might be a genetic trait with multiple alleles consisted of Na^+ gene, Na gene and na gene, which each gene might be codominant and additive traits,
5 The value of heritability based on roosters were 0.22 on the egg weight; 0.40 on the egg index and 0.51 on the hatched-egg weight.

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