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Physical and Chemical Characteristics of Maleo Egg in Bogani Nani Wartabone Park

JLP Saerang[1)*], W Manalu[2)], IRH Soesanto[3)], and A Mardiastuti[4)]

[1)]Faculty of Animal Science, University of Sam Ratulangi, Jl. Kampus UNSRAT Bahu, Manado 95115, Indonesia
[2)]Department of Anatomy, Physiology and Pharmacology, Bogor Agricultural University, Jl. Agatis, Bogor, Indonesia
[3)]Department of Animal Production and Technology, Bogor Agricultural University, Jl. Agatis, Bogor, Indonesia
[4)]Department of Conservation of Forest Resources and Ecotourism, Bogor Agricultural University, Jl. Lingkar Akademik, Bogor, Indonesia
[*]Corresponding author email: pinky_saerang@yahoo.com

Abstract. The objective of this study was to examine the size (weight, length, and width) of Maleo egg in Bogani Nani Wartabone National Park. Physical characteristics measured were: egg weight, egg shell thickness, egg index, yolk, and albumen. Two fresh egg were weighed with an electric balance. Length and width of egg used were measured by Vernier caliper, and egg shell thickness by a tripod micrometer, yolk color by yolk color fan. Physical characteristic egg that comprised of egg weight, egg width, egg length, egg index, albumen width, albumen length, albumen index, yolk width, yolk length, yolk index, albumen weight, yolk weight, egg shell thickness, and shell weight were 223.70 g, 104.00 mm, 56.68 mm, 56.41, 113.8 mm, 86.72 mm, 6,07%, 85.30 mm, 69.90 mm, 31.54%, 47.51 g, 110.80 g, 0:02-inch, 19:55 g, respectively. Maleo egg contained complete amino acids and fatty acids, including essential amino acids, non essential amino acids, saturated fatty acids and unsaturated fatty acids.

Key Words: Maleo bird, maleo egg, physical characteristics, chemical characteristics

Introduction

Maleo *(Macrocephalon maleo)* is a very unique bird, is one of the endemic fauna and nesting sites is limited because it can only be found in a particular region. National Park area of Bogani Nani Wartabone is the area that have the most nesting sites. The existence of these animals make Sulawesi region as an object for local, national, or international Maleo observers. In addition to the endemic birds, Maleo also have properties and behaviors that are very unique in their life cycle. Maleo laying cycles have not been deeply observed. Wiriosoepartho (1980) reported that approximately 6 to 10 birds returned to lay their egg. The number of egg produced by a female Maleo per year or per season is not known with certainty, but is expected to lay their egg every 12 to 13 days or about 30 egg a year (MacKinnon, 1981). Maleo proliferation activity was always vulnerable to predators. Based on the results of interviews with National Park Bogani Nani Wartabone officers, egg predators include lizard *(Varamus salvator),* wild pig *(Sus celebensis),* python *(Python reticulatus),* soa-soa *(Hydrosaurus amboinensis),* and humans. Sulawesi Hawk-eagle *(Spizaetus lanceolatus)* prey on Maleo chicks, while dogs disturb and prey on adults Maleo during laying time. These has resulted in declining populations of Maleo birds from year to year. Maleo birds in natural populations have declined sharply and habitat Maleo limited to a specific region. The conditions of Maleo population is not only being concerned by the government of Indonesia but also by the international worlds. IUCN *(International Union for Conservation of Nature and Natural Resources)* has put these animals into the *Red Data Book* in the category *"Endangered species".* Maleo birds population continually threatened by habitat conversion and increasing number of traditional harvesting of egg.

Maleo egg weigh 3 to 4 times duck egg, and 4 to 5 times chicken egg. How Maleo birds hatched their egg is amazing because their egg size is not comparable to the size of his body. Large egg yolks associated with the hatching process Maleo (Seymour, 1985). Newly hatched Maleo come out from of sandy soil

without any help, the eyes are open, and then able to fly. Maleo chicks take 1-2 days to break the egg shell and stormed out of the hole (MacKinnon, 1978). Small egg size is often the problem in young birds during peak production (Wu et al., 2007). This research was conducted to investigate and describe the physical and chemical characteristics Maleo egg.

Materials and Methods

Maleo egg were taken from nesting sites in the Bogani Nani Wartabone Park, Desa Tambun, Sub Dumoga, Bolaang Mongondow, North Sulawesi. Two Maleo egg were used, each egg was weighed and measured for its diameter (weight egg length, egg width and egg index). After the egg was broken, complete measurements of egg albumen, egg yolk, egg yolk color and egg egg shell were conducted. Egg albumen and yolk were measured by using a *tripod micrometer,* whereas the egg yolk color was measured with *Egg Color Fan.* After the physical measurements, egg were brought to the Integrated Laboratory of IPB for amino acid and fatty acids analysis. Amino acid analysis was performed by *High Performance Liquid Chromatography* and the fatty acid analysis was carried out by *Gas Chromatography***.** Data and information obtained were analyzed by descriptive and quantitative analysis.

Results and Discussion

Maleo egg have a unique morphometri for weight, length, width, and shape which were different from other avian species. Weight measurements of bird egg varies slightly. Wiriosoepartho (1979) stated that Maleo egg weight ranged from 223.95 to 253.20 grams, and length ranged from 10.5 to 11.2 cm. Dekker (1990) reported that Maleo egg weight ranged from 178 to 267 grams, length ranged from 92.1 to 112.6 mm, width ranged from 57.6 to 65.5 mm. Sumangando (2002) stated that Maleo egg weight ranged from 110 to 250 grams, length ranged from 9.7 - 10.7 cm, width ranged from 5.7 to 6.2 cm and egg index ranged from 55.0 to 61.0. Maleo egg found in the village of Tambun nesting sites were newly laid, with pink color, egg shell was not smooth, not shiny, and composed of two forms, namely the normal form-oval and oval-elliptical shape. Complete measurement of the physical quality of Maleo egg is shown in Table 1.

Maleo egg has average weight of 223.70 g, albumen weight of 72.23 g and yolk weight of 131.67 g. The two egg have different colors, and two forms of egg yolk. The color of egg yolk is affected by diet (Olson et al., 2008). Hafsa et al. (2006) reported that the physical characteristics of egg in the Lore Lindu Maleo Park were: egg weight 220 g, egg shell thickness 0.39mm, and egg index 72.42%. Physical composition of Maleo egg is different from other avian egg, because Maleo egg largely dominated by yolk. Egg yolk is the largest part of about 57.61% of the weight of the egg. Whereas in ducks, chickens and pigeons, albumen are the largest part (52.6%, 55.8% and 74%, respectively). Stadelman and Cotterill (1977) reported that chicken egg consists of 58% albumen, 30-31% yolk and 11% egg shell. Egg shell weight is affected by egg colour and hen age. It has been reported that shell thickness, yolk weight, and yolk index of pheasant egg decreased with hen age, but albumen weight and albumen index were increased (Demirel et al., 2009). The Maleo with egg shell weight of 228.6 g was lighter than that of 218.8 g. The Maleo egg with yolk weight of 116.5 g have lighter albumen weight when compared with that of 105.1 g. Based on the results of physical analysis, the Maleo egg with larger yolk have lighter albumen and eggshell.

Egg are excellent source of amino acids, fatty acids, vitamins, and minerals, and also contain approximately 213 mg of cholesterol (Aydin et al., 2008). Table 2 showed that Maleo egg have complete amino acid and fatty acids composition, including essential amino acids, non-essential amino acids, saturated fatty acids, and unsaturated fatty acids. The highest percentage of amino acid content is glutamic acid. According to Murray et al. (2003) glutamate and aspartate are amino acids in the brain, meaning glutamate and aspartate are amino acids that stimulate neurotransmision works. Glutamate is responsible for approximately 75% neurotransmision in the brain.

Table 1. Maleo egg physical quality (n = 2)

Components	Egg 1	Egg 2	Average ± standar deviation
Weight (g)	218.8	228.6	223.70 ± 4.90
Length (mm)	103.6	104.4	104.00 ± 0.40
Width (mm)	58.2	59.2	58.68 ± 0.48
Egg index	56.2	56.7	56.41 ± 0.24
Albumen height (mm)	9.5	6.3	7.86 ± 1.61
Albumen length (mm)	111.5	116.2	113.8 ± 2.35
Albumen width (mm)	90.5	83.0	86.72 ± 3.78
Albumen index (%)	7.6	4.5	6.07 ± 1.61
Yolk height (mm)	40.9	36.8	38.85 ± 2.05
Yolk length (mm)	79.9	90.7	85.30 ± 5.40
Yolk width (mm)	59.9	79.9	10.00 ± 69.90
Yolk index (%)	30.7	32.4	31.54 ± 0.88
Yolk color	14	15	--
Albumen weight (g)	72.32	70.56	71.44 ± 0.88
Yolk weight (g)	124.67	138.68	131.67 ± 7.05
Egg shell thickness (inch)	0.38	0.40	0.39 ± 0.01
Egg shell weight (g)	20.4	18.7	19.55 ± 0.82

Table 2. Maleo egg chemical analysis (n = 2)

Components	Egg 1 (%)	Egg 2 (%)	Average ± standar deviation
Amino acids			
Aspartate	1.2	1.1	1.15 ± 0.05
Glutamate	2.1	1.8	1.95 ± 0.15
Serine	1.1	0.9	1.00 ± 0.10
Histidine	0.4	0.3	0.35 ± 0.05
Glycine	0.5	0.4	0.45 ± 0.05
Threonine	0.7	0.6	0.65 ± 0.05
Arginine	0.8	0.8	0.85 ± 0.05
Alanine	0.7	0.6	0.65 ± 0.05
Tyrosine	0.6	0.5	0.55 ± 0.05
Methionine	0.5	0.4	0.45 ± 0.05
Valina	0.8	0.7	0.75 ± 0.05
Phenylalanine	0.6	0.5	0.55 ± 0.05
Isoleucine	0.7	0.6	0.65 ± 0.05
Leucine	1.2	1.1	1.15 ± 0.05
Lysine	0.9	0.7	0.80 ± 0.10
Fatty Acids			
C14: 0 (myristic)	3.2	6.1	4.65 ± 1.45
C16: 0 (palmitic)	24.2	20.4	22.30 ± 1.90
C18: 0 (stearic)	12.4	9.5	10.95 ± 1.45
C18: 1 (oleic)	15.5	9.4	12.45 ± 3.05
C18: 2 (linoleic)	3.2	4.6	3.90 ± 0.70
C20: 0 (arachidonic)	0.1	0.1	0.10 ± 0.00
C18: 3 (linolenic)	0.9	0.8	0.85 ± 0.05
C22: 0 (Behenat)	0.2	0.2	0.20 ± 0.00
C22: 1 (Erusat)	0.1	0.1	0.10 ± 0.00
Phosphorus	0.2	4.8	2.50 ± 2.30
Calcium	0.1	0.1	0.10 ± 0.00
Potassium	0.1	0.1	0.10 ± 0.00
Sodium	0.1	0.1	0.10 ± 0.00
Gynecology Fat	15.7	19.8	17.75 ± 2.05

Table 3. Proxymate analysis of Maleo egg compared to other birds egg (per 100 grams)

Composition	Maleo [1)]	Chicken [2)]	Ducks [2)]	Quail [2)]
Water	51.05	72.90	70.10	72.60
Fat	23.31	11.10	13.60	12.40
Abu	1.51	1.30	1.20	1.00
Protein	29.15	13.20	12.60	12.40
Carbohydrates	1.03	1.50	2.50	1.60
Crude fiber	0.01	0.00	0.00	0.00
Calories	3713	159	183	168

1) Integrated Laboratory IPB, Bogor, 2009
2) Asean Food Composition Tables, 2000

Maleo egg have nutrient quality higher than other birds egg. This causes Maleo chicks have the ability to get out of the sand. Essential fatty acids found in lipid structures of cells with high concentrations in the reproductive organs. Essential fatty acid deficiency resulted in growth retardation, decreased in reproductive capacity and resistance (Murray et al., 2003). Chicken egg composed of 65% albumen and 35% yolk. Yolk total solid generally consisted of 50% to 16% protein and 32% fat. Fatty acids are the major components of chicken egg yolk lipids and constitute over 4 g in an average egg (Cherian, 2008). Conjugated linoleic acid (CLA) increased the ratio of saturated fatty acid to monounsaturated fatty acid in yolk and cause embryo mortality (Aydin and Cook., 2004). Large egg yolks with amino acids and fatty acids were needed for embryo development until the chicks hatched, and out of the ground. Newly hatched Maleo chick must be fully independent. Maleo chicks' ability to get out of the sand pile is supported by the physical condition of the prime body. Food reserves, including the quality and amount of nutrients is closely related to egg hatching ability and durability of Maleo chicks to get out of the nesting sand. Research Team of Fapet Unsrat (1989) reported that this condition is positively correlated with observations on the amount of reserve food *(egg yolk),* which is quite a lot of (± 15g) in the abdominal cavity lining of Maleo chicks at the time they hatched.

Conclusions

Maleo egg found in the village of Tambun nesting sites were newly laid, have pink color, egg shell were not smooth, not shiny, and consisted of two forms, that were the normal oval and an oval ellipse shapes. Maleo egg yolk consisted of complete amino acid and fatty acids composition, including essential amino acids, non-essential amino acids, saturated fatty acids, and unsaturated fatty acids. This yolk provide complete nutrients needed for the development of Maleo chicks, from embryonic stage to the time the chicks hatched, and get out from the nesting ground.

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