

Hematological, electrolyte and serum biochemical values of the Thai indigenous chickens (*Gallus domesticus*) in northeastern, Thailand

Suchint Simaraks¹, Orawan Chinrasri² and Worapol Aengwanich³

Abstract

Simaraks, S., Chinrasri, O. and Aengwanich, S.

Hematological, electrolyte and serum biochemical values of the Thai indigenous chickens (*Gallus domesticus*) in northeastern, Thailand

Songklanakar J. Sci. Technol., 2004, 26(3) : 425-430

Thai indigenous chickens (*Gallus domesticus*) have been domesticated in rural villages in Thailand for a long time. These birds are important to low-income people who live in the rural part of Thailand. However, health problems have been a major cause limiting their population. Hematological, electrolyte and serum biochemical values, which are important for diagnosis of clinical signs and symptoms when affected by diseases, are limited. Blood samples from 40 chickens (20 males and 20 females) were used for hematological test while another 18 samples (from 10 males and 8 females) were analysed for electrolyte and serum biochemical values. The samples were obtained from Khon Kaen, Kalasin, Roi - Et, Maha Sarakham and Nakhon Ratchasima provinces, northeastern region of Thailand. The results revealed the following information: total red blood cell count, hemoglobin concentration, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, total white blood cell count, lymphocyte, heterophil, monocyte, eosinophil, basophil, H:L ratio values of Thai native chickens

¹D.V.M., Ph.D. (Physiology of Reproduction), Assoc. Prof., Department of Animal Science, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, ²M.Sc. (Animal Science), ³D.V.M. (Physiology), Division of Animal Production Technology, Department of Agricultural Technology, Faculty of Technology, Mahasarakham University, Maha Sarakham 44000, Thailand.

Corresponding e-mail: Worapol.a@msu.ac.th

Received, 21 August 2003

Accepted, 14 January 2004

were $2.26 \pm 0.29 \times 10^6$ cells/ μ l, 8.89 ± 1.20 g/dl, $32.18 \pm 4.46\%$, 144.63 ± 18.61 fl, 39.69 ± 4.96 pg, 27.86 ± 3.37 g/dl, $2.04 \pm 0.45 \times 10^4$ cells/ μ l, $63.68 \pm 9.36\%$, $23.70 \pm 7.21\%$, $4.20 \pm 3.20\%$, $5.83 \pm 3.53\%$, $2.65 \pm 2.09\%$ and 0.40 ± 0.17 , respectively. Potassium, sodium and chloride values of Thai native chickens were 5.3 ± 0.8 mmol/l, 155.9 ± 3.1 mmol/l and 116.9 ± 2.7 mmol/l, respectively. Furthermore, serum biochemistry values of Thai native chickens such as total protein, glucose, alkaline phosphatase, uric acid, calcium and cholesterol were 4.6 ± 1.0 mg/dl, 190.2 ± 29.8 mg/dl, 235.9 ± 68.6 U/L, 5.0 ± 1.9 mg/dl, 10.4 ± 1.2 mg/dl and 102.4 ± 30.8 mg/dl, respectively. Besides, hemoglobin concentration, packed cell volume and eosinophil in the males were significantly higher than in the females Thai indigenous chickens ($P < 0.05$), lymphocyte counts of the females were significantly higher than the males ($P < 0.05$). From serum biochemical values, potassium, sodium, total protein and uric acid of female indigenous birds were significantly higher than males ($P < 0.05$).

Key words : hematological, electrolyte and blood biochemistry, Thai indigenous chickens

บทคัดย่อ

สุจินต์ สิมารักษ์¹ อรวรรณ ชินราศรี² และ วรพล เองวานิช²
 คำโลหิตวิทยา อีเลคโตรไลต์และชีวเคมีโลหิตของไก่พื้นเมือง (*Gallus domesticus*) ที่เลี้ยงใน
 ภาคตะวันออกเฉียงเหนือของประเทศไทย

ว. สงขลานครินทร์ วทท. 2547 26(3) : 425-430

ไก่พื้นเมืองไทยเป็นไก่ป่าที่นำมาเลี้ยงไว้ตามบ้านมาเป็นเวลานานแล้ว และมีความสำคัญกับชาวชนบทผู้มีรายได้น้อยในทุกภาคของประเทศ อย่างไรก็ตามปัญหาทางด้านสุขภาพทำให้จำนวนของไก่ไม่สามารถเพิ่มขึ้นได้เท่าที่ควรจะเป็น คำโลหิตวิทยา อีเลคโตรไลต์ และชีวเคมีโลหิต มีความสำคัญในการวินิจฉัยอาการผิดปกติทางคลินิกและอาการที่ปรากฏขึ้นจากโรคชนิดต่าง ๆ การศึกษาคำโลหิตวิทยาในครั้งนี้ใช้ไก่พื้นเมืองสุขภาพดีจำนวน 40 ตัว (เพศผู้และเพศเมียชนิดละ 20 ตัว) และค่าอีเลคโตรไลต์ และค่าชีวเคมีโลหิตศึกษาในไก่พื้นเมืองจำนวน 18 ตัว (เพศผู้ 10 ตัวและเพศเมีย 8 ตัว) โดยนำไก่มาจากจังหวัดขอนแก่น กาฬสินธุ์ ร้อยเอ็ด มหาสารคาม และนครราชสีมา ผลการศึกษามีดังต่อไปนี้ ค่าจำนวนเม็ดเลือดแดงทั้งหมด ความเข้มข้นฮีโมโกลบิน เฟอร์เรตินเม็ดเลือดแดงอัดแน่น ค่าเฉลี่ยปริมาตรเม็ดเลือดแดง ค่าเฉลี่ยฮีโมโกลบิน ค่าเฉลี่ยความเข้มข้นฮีโมโกลบิน จำนวนเม็ดเลือดขาวทั้งหมด เฟอร์เรตินเม็ดเลือดขาวชนิดลิมโฟไซต์ เฟอร์เรตินเม็ดเลือดขาวชนิดเฮเทอโรฟิล เฟอร์เรตินเม็ดเลือดขาวชนิดโมโนไซต์ เฟอร์เรตินเม็ดเลือดขาวชนิดอีโอซิโนฟิล เฟอร์เรตินเม็ดเลือดขาวชนิดแบซิฟิล อัตราส่วนระหว่างเฟอร์เรตินเม็ดเลือดขาวชนิดเฮเทอโรฟิลต่อลิมโฟไซต์ของไก่พื้นเมืองมีค่าเท่ากับ $2.26 \pm 0.29 \times 10^6$ cells/ μ l, 8.89 ± 1.20 g/dl, $32.18 \pm 4.46\%$, 144.63 ± 18.61 fl, 39.69 ± 4.96 pg, 27.86 ± 3.37 g/dl, $2.04 \pm 0.45 \times 10^4$ cells/ μ l, $63.68 \pm 9.36\%$, $23.70 \pm 7.21\%$, $4.20 \pm 3.20\%$, $5.83 \pm 3.53\%$, $2.65 \pm 2.09\%$ และ $0.40 \pm 0.17\%$ ตามลำดับ ค่าโปแตสเซียม โซเดียม คลอไรด์ ของไก่พื้นเมืองมีค่าเท่ากับ 5.3 ± 0.8 mmol/l, 155.9 ± 3.1 mmol/l และ 116.9 ± 2.7 mmol/l ตามลำดับ นอกจากนี้ค่าโปรตีนทั้งหมด กลูโคส อัลคาไลน์ฟอสฟาเตส กรดยูริก แคลเซียม และโคเลสเตอรอลของไก่พื้นเมืองเท่ากับ 4.6 ± 1.0 g/dl, 190.2 ± 29.8 mg/dl, 235.9 ± 68.6 U/L, 5.0 ± 1.9 mg/dl, 10.4 ± 1.2 mg/dl และ 102.4 ± 30.8 mg/dl ตามลำดับ นอกจากนี้ยังพบว่าค่าความเข้มข้นฮีโมโกลบิน เฟอร์เรตินเม็ดเลือดแดงอัดแน่น และอีโอซิโนฟิล ของไก่พื้นเมืองเพศผู้มีค่าสูงกว่าเพศเมีย ($P < 0.05$) ค่าจำนวนเม็ดเลือดขาวชนิดลิมโฟไซต์ของไก่เพศเมียมีค่าสูงกว่าเพศผู้ ($P < 0.05$) จากค่าชีวเคมีโลหิตพบว่า ค่าโปแตสเซียม โซเดียม โปรตีนทั้งหมด และกรดยูริกของไก่พื้นเมืองเพศเมียมีค่าสูงกว่าไก่เพศผู้ ($P < 0.05$)

¹ภาควิชาสัตวศาสตร์ คณะเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น อำเภอเมือง จังหวัดขอนแก่น 40002 ²สาขาวิชาเทคโนโลยีการผลิตภัณฑ์ ภาควิชาเทคโนโลยีการเกษตร คณะเทคโนโลยี มหาวิทยาลัยมหาสารคาม อำเภอเมือง จังหวัดมหาสารคาม 44000

Thai indigenous chickens (*Gallus domesticus*) originated from red jungle fowl (*Gallus gallus*) in Southeast Asia (Say, 1987; Parkhurst and Mountney, 1988; Siller and Wight, 1997). These birds have been reared by free ranging under backyard system in Thailand. Thai indigenous birds can be "stored" on the farm as live birds and slaughtered a few at a time as needed. Besides, the low initial cost of egg production, equipment, and housing enables low-income farmers to provide a source of meat protein with low investment.

In general, blood examination is performed for several reasons as a screening procedure to assess general health (Jain, 1993). Glucose, cholesterol, calcium, total protein, alkaline phosphates, uric acid, sodium, potassium, chloride levels are diagnostic values for diabetes mellitus, liver disease, hypoparathyroidism, chronic hepatopathy and liver disease, gout, kidney disease, chronic diarrhea and dehydration, respectively. Besides, hematological values are important to clinicopathological diagnosis such as traumatic injury, parasitism, organic disease, bacterial septicemia and nutritional deficiencies. Moreover, managing abnormalities in birds requires an understanding of how diseases change the biochemical function and electrolyte of the bodies. Because the clinical signs of illness in birds are frequently subtle, clinical chemistry is necessary to evaluate cellular changes (Ritchie *et al.*, 1994). However, the literature on hematological, electrolyte and serum biochemical values of Thai indigenous birds is limited. Therefore, the objective of this study was to establish hematological, electrolyte and serum biochemical values for Thai indigenous chickens. These values could be used for clinical pathological diagnosis and other studies.

Materials and Methods

Birds: Fifty-eight healthy Thai indigenous chickens, 6-8 months of age, were obtained from Khon Kaen, Kalasin, Roi-Et, Maha Sarakham and Nakhon Ratchasima provinces, in the region of northeastern Thailand. These birds were reared in

the experimental laboratory unit of Faculty of Technology, Maha Sarakham University, for 4 months. A standard feeding program with commercial diets was used (18% cp, 3.2 Kcal/g ME). Continuous light, feed and water were provided *ad libitum* throughout the experiment. The Thai native chickens were divided into two groups: Group I, 20 males and 20 females birds were determined for hematological; Group II, (10 males and 8 females) chickens were determined for electrolyte and biochemistry values, respectively. Three ml of blood was obtained from the wing vein using a 3 ml syringe and 23 gauge needle, then immediately transferred into 2 tubes; 1 ml into the first tube containing EDTA for hematological determination and 2 ml into the second tube without anticoagulant for other serum biochemistry determination. The samples were kept in an ice box, using icepacks and transferred to the laboratory for further assays.

Hematological technique

Differential WBC counts were made on monolayer blood films, fixed and stained with Giemsa-Wright's stain. Total red blood cell (TRBC) and total white blood cell count (TWBC) were determined by a manual method using hemacytometer (Campbell, 1995). Packed cell volume (PCV) was measured by a standard manual technique using microhematocrit capillary tubes and centrifuged at 2500 rpm for 5 min. Hemoglobin concentration (Hb) was measured by Cyanmethemoglobin method. Erythrocyte indices (mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentrations (MCHC)) were calculated from TRBC, PCV and Hb (Ritchie *et al.*, 1994), respectively.

Electrolyte and biochemicals technique

Serum electrolyte (potassium, sodium and chloride) and biochemistry values (total protein, glucose, alkaline phosphatase, uric acid, calcium and cholesterol) were determined by automatic analyzer (Kodak Ektachem®; Eastman Kodak

Company, Rochester, New York).

Statistical analysis: All values of hematological, electrolyte and serum biochemical values were expressed as mean \pm standard deviation. Parameters of both sexes were compared using Student's *t*-test. The level of significance was reported at $P < 0.05$.

Results and Discussion

The relation of sex to hematological, electrolyte and serum biochemical values in Thai indigenous chickens, and hematology, electrolyte and serum biochemistry profiles of these chickens is presented in Tables 1 and 2.

Table 1. Hematological values of Thai indigenous chickens.

Parameters	Sex		Total (n=40)	Range	Reference**
	Male (n=20)	Female (n=20)			
Hemoglobin (g/dl)	9.27 \pm 1.42*	8.52 \pm 0.85	8.89 \pm 1.20	8 - 10	7.0 - 13.0
Total RBC ($\times 10^6$ μ l)	2.32 \pm 0.31	2.19 \pm 0.26	2.26 \pm 0.29	2 - 3	2.5 - 3.5
PCV (%)	33.55 \pm 4.72*	30.80 \pm 3.96	32.18 \pm 4.46	28 - 37	22.0 - 35.0
MCV (fl)	147.87 \pm 18.43	141.39 \pm 19.17	144.63 \pm 18.61	126 - 163	90.0 - 140.0
MCH (pg)	40.26 \pm 5.16	39.11 \pm 4.42	39.69 \pm 4.96	35 - 45	33.0 - 47.0
MCHC (g/dl)	27.93 \pm 4.56	27.79 \pm 1.77	27.86 \pm 3.37	24 - 31	26.0 - 35.0
Total WBC ($\times 10^4$ μ l)	2.05 \pm 0.39	2.05 \pm 0.53	2.04 \pm 0.45	1.6 - 2.5	1.2 - 3.0
Heterophil (%)	25.40 \pm 5.12	22.00 \pm 8.78	23.70 \pm 7.21	16 - 31	15.0 - 40.0
Lymphocyte (%)	60.30 \pm 5.33	67.05 \pm 11.49*	63.68 \pm 9.36	54 - 73	45.0 - 70.0
Eosinophil (%)	7.35 \pm 2.91*	4.30 \pm 3.59	5.83 \pm 3.53	2 - 9	1.5 - 6.0
Monocyte (%)	4.35 \pm 3.15	4.05 \pm 3.39	4.20 \pm 3.20	1 - 7	5.0 - 10.0
Basophil (%)	2.70 \pm 2.13	2.60 \pm 2.16	2.65 \pm 2.09	1 - 5	Rare
H: L ratio	0.43 \pm 0.12	0.36 \pm 0.21	0.40 \pm 0.17	0.23 - 0.57	-

* Mean \pm SD with superscript, within row between sex in each parameter differ significantly ($P < 0.05$),

** Reference values of Jain (1993)

Table 2. Serum electrolyte and biochemical values of Thai indigenous chickens.

Parameters	Sex		Total (n=18)	Range	Reference**
	Male (n=10)	Female (n=8)			
Potassium (mmol/l)	4.8 \pm 0.5	5.8 \pm 0.7*	5.3 \pm 0.8	4 - 6	1.7 - 4.2
Sodium (mmol/l)	154.8 \pm 1.7	157.4 \pm 3.4*	155.9 \pm 3.1	153 - 159	139 - 155
Chloride (mmol/l)	115.7 \pm 2.0	118.0 \pm 2.9	116.9 \pm 2.7	114 - 120	108 - 124
Total protein (mg/dl)	3.9 \pm 0.6	5.2 \pm 0.9*	4.6 \pm 1.0	4 - 6	3.0 - 4.9
Glucose (mg/dl)	180.4 \pm 33.1	202.4 \pm 21.0	190.2 \pm 29.8	160 - 220	197 - 299
ALP (U/l)	228.7 \pm 53.1	244.0 \pm 86.0	235.9 \pm 68.6	167 - 305	10 - 106
Uric acid (mg/dl)	3.6 \pm 1.2	6.4 \pm 1.3*	5.0 \pm 1.9	3 - 7	1.9 - 12.5
Calcium (mg/dl)	10.3 \pm 0.8	10.1 \pm 1.5	10.4 \pm 1.2	9 - 12	8.1 - 12
Cholesterol (mg/dl)	101.7 \pm 19.4	103.1 \pm 41.0	102.4 \pm 30.8	72 - 133	129 - 297

* Mean \pm SD with superscript, within row between sex in each parameter differ significantly ($P < 0.05$),

** Reference values of Clinical Diagnostic Division (1990).

The MCV of Thai indigenous chickens was higher, but the TRBC and percentages of monocyte were lower, than reference range reported by Jain (1993) (Table 1). Hb and PCV of male chickens were higher than that of females. These were similar to the report by Sturkie (1965) that Hb and PCV were influenced by androgen. Percentage of lymphocytes in females was higher than in male chickens. On the other hand, eosinophil in male was significantly higher than female. Potassium and alkaline phosphatase were higher, glucose and cholesterol were lower than reference range indicated by Clinical Diagnostic Division (1990) (Table 2). These indicated that some hematological, electrolyte and blood biochemical values of Thai indigenous chickens were different from reference values reported overseas.

Generally serum glucose of juvenile is lower than that of mature chickens (Ritchie *et al.*, 1994), and the glucose levels of female (109 g/dl) are lower than that of male (114g/dl) chickens (Sturkie, 1965). This is similar to the report of Homswat *et al.* (1999). They compared glucose level of male pheasant (218.52±22.32 mg/dl) with that of females (266.4±21.60 mg/dl), but in the present study serum glucose levels of Thai indigenous chickens were not significantly different between sexes (Table 2). In birds, uric acid is a major product of the catabolism of nitrogen. Age and diet may influence the concentration of blood uric in birds. Besides, hyperuricemia has been documented during ovulatory activity (Ritchie *et al.*, 1994). This agreed with increased serum uric acid of female Thai indigenous chickens in this study, because they started laying. Therefore, serum uric acids in female were significantly higher than in male indigenous birds. This phenomenon was in accordance with the report by Sturkie (1965), who reviewed that serum uric acid of mature females (5.40 mg/dl) was higher than that of males (2.86 mg/dl) and serum uric acid of laying birds (0.76 mg/dl) was lower than in non-reproductive females (1.80 mg/dl).

Total protein of female Thai indigenous bird was higher than in males (Table 2). This result

was similar to the report by Meluzzi *et al.* (1992), who studied the serum total protein in broilers chickens. Besides, in female birds, a considerable increase in plasma total protein concentration occurs just prior to egg laying, which could be attributed to an estrogen-induced increase in globulins. The proteins were the yolk precursors (vitellin and lipoproteins), which were synthesized in the liver and transported *via* the plasma to the ovary where they were incorporated in the oocytes (Ritchie *et al.*, 1994). Moreover, total proteins of Thai indigenous chickens were lower than the normal range of the domestic turkey (4.9-7.6 mg/dl) and pheasant (male=5.65 mg/dl; female=6.06 mg/dl), but higher than the normal range of the guinea fowl (3.5-4.4 mg/dl) and common quail (3.4-3.6 mg/dl) (Ritchie *et al.*, 1994). Cholesterol of these indigenous birds was not significantly different between sexes, similar to the report in pheasant by Homswat *et al.* (1999) (male=256.19±42.57 mg/dl; female=236.46±35.22 mg/dl). Besides, serum cholesterol of these Thai indigenous chickens was lower than the reference range (Clinical Diagnostic Division, 1990) (Table 2) and broilers (140 mg/dl) (Meluzzi *et al.*, 1992).

Sodium is present mainly in the extracellular fluid and is primarily responsible for determining the volume of the extracellular fluid and its osmotic pressure. Intracellular sodium levels are kept low by a relatively impermeable cell membrane and a sodium pump, which removes sodium from the cells. Sodium plasma levels are maintained within narrow limits, despite wide fluctuation in dietary intake (Ritchie *et al.*, 1994). The normal ranges of serum sodium in mature birds were 130-150 mmol/l (Sturkie, 1965) and were not different between sexes (Homswat *et al.*, 1999). However, serum sodium levels in Thai indigenous chickens were significantly different between males and females (Table 2). Serum chloride levels in Thai indigenous birds were not different from the reference range and were not significantly different between sexes (Table 2). This was similar to plasma chloride in pheasant (male=108.84±7.05 mmol/l; female= 119.61±8.19

mmol/l) (Siller and Wight, 1997).

Ovulating hens have significantly higher calcium levels than non-reproductive females (Ritchie *et al.*, 1994). This agrees with Kunjarathitiyapung *et al.* (1987) who compared the levels of serum calcium between laying hens (18.10 ± 2.64 mg/dl) and broilers (6.25-13.75 mg/dl). In this study the serum calcium levels in indigenous birds were not different between the sexes and this was similar to the report by Meluzzi *et al.* (1992) (10.47 mg/dl). Besides, serum calcium of Thai indigenous chickens was lower than in domestic turkey (11.7-38.7 mg/dl), domestic fowl (13.2-23.7 mg/dl) and bobwhite quail (14.1-15.4 mg/dl) (Ritchie *et al.*, 1994). Meluzzi *et al.* (1992) reported that plasma alkaline phosphatase in males (2,427 IU/L) was significantly higher than in female broilers (2,070 IU/L) (normal range between 568-8,831 IU/L), which was different from that reported by Ritchie *et al.* (1994) and Homswat *et al.* (1999), who reported in laying hens and pheasants, respectively. However, serum alkaline phosphatase of this study was not different between sexes (Table 2).

References

- Campbell, T. W. 1995. Avian Hematology and Cytology, Iowa State University Press. Ames, Iowa.
- Clinical Diagnostic Division. 1990. Veterinary Reference Guide, Eastman Kodak Company, Rochester, New York.
- Homswat, S., Nimitsuntiwong, W., Boonyaparakob, U., Kaewmukul, S. and Schmidt, A. 1999. Blood chemistry, hematology, plasma protein electrophoretic patterns and hemoglobin electrophoretic bands in pheasant. Kasetsart J. (Nat. Sci.) 33, 377-385. (in Thai)
- Jain, N. C. 1993. Essential of Veterinary Hematology, Lea & Febiger, Philadelphia.
- Kunjarathitiyapung, C. and Ruenosuphaphichat, P. 1987. Studies on the mineral elements in serum of laying hens and laying ducks, Kasetsart Veterinarians 8 (1), 58-63. (in Thai)
- Meluzzi, A., Primiceri, G., Giordani, R. A., and Fabris, G. 1992. Determination of blood constituents reference values in broilers, Poult. Sci. 71, 337-345.
- Parkhurst, C. R. and Mountney, G. S. 1988. Poultry Meat and Egg Production, Van Nostrand Reinhold, New York.
- Ritchie, B. W., Harrison, J. G. and Harrison, R. L. 1994. Avian Medicine, Winger's Publishing, Inc, Florida.
- Say, R. R. 1987. Manual of Poultry Production in the Tropics, CAB International, Wallingford.
- Siller, W. G. and Wight, P. A. L. 1997. Anatomy of the Domestic Birds, Verlag Paul Parey, Berlin and Hamburg.
- Sturkie, P.D. 1965. Avian Physiology, Comstock Publishing Associates, New York.