

MINERAL COMPOSITIONS OF CHICKEN', QUAIL' AND SNAIL-EATING TURTLE'S EGGS

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ABSTRACT: This study was aimed to evaluate mineral compositions, of chicken, quail and snail-eating turtle eggs. Total essential minerals of all eggs were higher in egg whites than egg yolks but total of trace minerals of all eggs were higher in egg yolks. Most of essential minerals in all eggs was nitrogen but most of trace mineral were iron, copper and zinc. The most of essential minerals in whole eggs of all eggs were nitrogen which was highest in snail-eating turtle (10.83 %). While, the most trace minerals of whole eggs in chicken, quail, and snail-eating turtle were iron (64.20 %), iron (80.80 %) and zinc (68.70 %) respectively. But total of trace minerals in whole eggs was highest in quail. An average level of iron in the whole quail egg was significantly higher than that of the chicken egg ($p < 0.001$), and snail-eating turtle egg ($p < 0.001$), respectively. However, total essential mineral levels was highest in quail egg whites (13.80 %) while total of trace mineral levels was highest in quail egg yolks (215.00 mg/L). The result of this study suggested that the chicken and quail eggs were sources of trace mineral of iron which is essential to hemoglobin, but the snail-eating turtle egg was a source of trace mineral of zinc which is essential to human health. There were high levels of nitrogen, phosphorous, calcium, magnesium, manganese and zinc in whole snail-eating turtle eggs which may be mineral source for health benefit.

Keywords: Mineral compositions, Chicken, Quail, Snail-eating turtle, Egg

INTRODUCTION

Minerals are essential for functional roles as important co-enzymes in the body, promoting health and growth [1, 2] which minerals are usually classified in two groups of essential minerals such as sodium, potassium, phosphorus, magnesium, calcium and trace minerals such as iodine, fluorine, zinc, iron, selenium, nickel etc. [3]. For example, nitrogen is an important constituent of DNA, nucleic acids and proteins [4] and calcium is essential for bones and teeth formations, blood coagulation [5], cardiac function [6] muscles contraction [7], and milk production [8]. Iron is essential for hemoglobin formation [9], brain development and function [10, 11], body temperature regulation [12, 13], muscle activity [14, 15] etc. Zinc is essential for insulin synthesis [16, 17] and immune functions [18]. The deficiency of minerals can lead to various deficiency disorders. Iron deficiency leads to anemia [19, 20] goiter-hypothyroidism [21], impaired mental function [22], neurological cretinism [23], myxedemaous cretinism [24]. Calcium deficiency may lead to rickets and osteomalacia [25] when associated with low vitamin D levels.

Zinc deficiency results in growth failure [26] but high doses of zinc and/or zinc supplements (more than 100 mgs daily) over a prolonged period of time

may actually impair rather than enhance immune function [27]. A balanced diet of human containing adequate amount of these minerals is essential for health. Eggs are a good source of minerals such as calcium, iron, phosphorus, zinc and iodine. The nutritional value of eggs makes it good for immunity, strong vision, treatment of macular degeneration, cataract treatment, skin care, nervous system, strong bones, and blood formation. Recent research has also shown that consuming eggs does not lead to increase in serum cholesterol levels [28]. The chicken egg is the most commonly eaten eggs which the most mineral compositions are phosphorous (25%), zinc (11%), iron (9%), magnesium (3%) and potassium (3%) [29]. Other bird eggs such as duck, quail and turkey have higher nutritional value in terms of mineral content and cholesterol percentage than chicken eggs [30]. Quail eggs are an especially good source of the trace minerals, especially iron and selenium. Human body needs adequate intakes of selenium to make antioxidant enzymes that protect cells against free-radical damage, which might decrease risk of developing chronic diseases such as heart disease or cancer [31]. Previous studies were evaluated chemical compositions, amino acids, fatty acids, vitamin and sex hormone contents of eggs from chicken, quail and snail-eating turtle and results showed that quail egg was higher in protein, fat and energy, as well as vitamin A and D, while, the chicken egg was higher of carbohydrates, vitamin E and sex hormones progesterone. The snail-eating

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Table 1 Ash, Moisture and Minerals of chicken, quail and snail-eating turtle whole eggs

Parameters	Chicken Mean $\pm$ S.D.	Quail Mean $\pm$ S.D.	Snail-eating turtle Mean $\pm$ S.D.
Ash (g 100g ⁻¹)	0.88 $\pm$ 0.01 ^e	1.06 $\pm$ 0.05 ^d	1.45 $\pm$ 0.11 ^{d,e}
Moisture (%)	77.73 $\pm$ 1.29 ^{h,i}	69.76 $\pm$ 0.38 ^h	69.92 $\pm$ 1.96 ⁱ
Essential Minerals			
Nitrogen (N, %)	8.03 $\pm$ 0.42 ^e	6.36 $\pm$ 0.08 ^{e,g}	8.66 $\pm$ 0.01 ^g
Phosphorous (P, %)	0.66 $\pm$ 0.02 ⁱ	0.70 $\pm$ 0.02 ^g	1.17 $\pm$ 0.01 ^{g,i}
Potassium (K, %)	0.50 $\pm$ 0.05	0.45 $\pm$ 0.02	0.50 $\pm$ 0.03
Calcium (Ca, %)	0.17 $\pm$ 0.01 ^{h,i}	0.20 $\pm$ 0.00 ^{g,h}	0.42 $\pm$ 0.00 ^{g,i}
Magnesium (Mg, %)	0.05 $\pm$ 0.01 ^{h,i}	0.04 $\pm$ 0.00 ^h	0.08 $\pm$ 0.00 ^{g,i}
Total essential minerals (%)	9.42 $\pm$ 0.50 ^{h,i}	7.75 $\pm$ 0.12 ^{g,h}	10.83 $\pm$ 0.04 ^{g,i}
Trace Minerals			
Iron (Fe, mg/L)	64.20 $\pm$ 4.38 ^{e,i}	80.80 $\pm$ 5.19 ^{e,g}	32.7 $\pm$ 3.43 ^{g,i}
Manganese (Mn, mg/L)	0.74 $\pm$ 0.26 ^f	0.71 $\pm$ 0.04 ^d	1.67 $\pm$ 0.14 ^{d,f}
Copper (Cu, mg/L)	4.85 $\pm$ 0.69 ^e	3.80 $\pm$ 0.55 ^e	3.98 $\pm$ 0.01
Zinc (Zn, mg/L)	41.4 $\pm$ 1.04 ^{h,i}	46.9 $\pm$ 1.06 ^{g,h}	68.70 $\pm$ 0.03 ^{g,i}
Total of trace minerals (mg/L)	111.20 $\pm$ 6.37 ^e	132.20 $\pm$ 6.84 ^{d,e}	107.10 $\pm$ 3.71 ^d

^{a,b,c} significant difference between types of egg at $p < 0.05$

^{d,e,f} significant difference between type of eggs at $p < 0.01$

^{g,h,i} significant difference between type of eggs at $p < 0.001$

turtle egg was higher in ash content (or of mineral content) [32] but lack of mineral composition information. The aim of our study was to compare mineral compositions of chicken, quail and snail-eating turtle eggs.

MATERIALS AND METHODS

Sample Collection

Chicken (*Gallus gallus*) and quail (*Coturnix coturnix japonica*) eggs were purchased from local market Ayutthaya, and snail-eating turtle (*Malayemys macrocephala*) eggs were purchased from a provider in Bangban district, Ayutthaya province during November 2009 to March 2010 and all of them were transported to the laboratory. They were stored at 4°C until used for sample preparation and analyses within one week.

Samples Preparation and Analyses

Egg samples were separated for whole, egg white, and egg yolk and homogenized by a laboratory blender, and analyzed for moisture and mineral compositions of nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn).

Sample Analyses

Moisture Analysis

Moisture analysis was done by using an Association of Official Agricultural Chemists (AOAC) [33] method.

Minerals Analyses

All samples were oven dried before ashing at 550 C. for 5 hours. Addition of 20 mL of 1 N hydrochloric acid (HCl) followed by minerals analysis by Inductively Couple Plasma (ICP) [34], for the mineral compositions of phosphorous (P),

potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), copper (Cu), zinc (Zn) and nitrogen (N) analysis [35].

Statistical Analyses

Statistical analyses were carried out using descriptive statistical analysis and compared with One-Way Analysis of Variance (ANOVA); Post Hoc Multiple Comparison (LSD). Mean differences with $p < 0.05$, $p < 0.01$ and $p < 0.001$ were considered statistical significant. All statistical analyses performed by SPSS for window version 17.0.

RESULTS

Average moisture content of whole chicken egg was higher than those of the snail-eating turtle and the quail eggs ($p < 0.001$ and $p < 0.001$). Essential mineral compositions in the whole egg was the highest in the snail-eating turtle (10.83 %), which the highest of nitrogen, phosphorous, calcium and magnesium. But whole quail egg was highest of trace mineral levels (132.20 %), which it was highest of iron (80.80 %). Total essential and trace minerals of chicken eggs were 9.42% and 111.20% which were high of nitrogen and iron respectively (Table 1).

Total essential mineral level of quail egg white (13.80 %) was significantly higher than those of the chicken (13.70 %, $p < 0.001$) and snail-eating turtle eggs (13.11 %, $p < 0.001$). But total trace mineral level of the snail eating turtle egg (97.30 mg/L) was higher than those of the chicken (49.40 mg/L, $p < 0.001$) and quail egg whites (26.00 mg/L, $p < 0.001$) (Table 2). Most of essential mineral of all egg whites was nitrogen while most of trace minerals was iron.

Table 2 Moisture and Minerals of chicken, quail and snail-eating turtle egg whites

Parameters	Chicken Mean $\pm$ S.D.	Quail Mean $\pm$ S.D.	Snail-eating turtle Mean $\pm$ S.D.
Moisture (%)	88.22 $\pm$ 0.22 ^{e,i}	87.76 $\pm$ 0.19 ^{e,g}	96.68 $\pm$ 0.08 ^{g,i}
Essential Minerals			
Nitrogen (N, %)	12.20 $\pm$ 0.33 ⁱ	12.2 $\pm$ 0.22 ^g	7.68 $\pm$ 0.01 ^{g,i}
Phosphorous (P, %)	0.09 $\pm$ 0.00 ^{h,i}	0.12 $\pm$ 0.01 ^{g,h}	1.21 $\pm$ 0.00 ^{g,i}
Potassium (K, %)	1.25 $\pm$ 0.20 ⁱ	1.31 $\pm$ 0.06 ^g	3.17 $\pm$ 0.10 ^{g,i}
Calcium (Ca, %)	0.07 $\pm$ 0.02 ⁱ	0.06 $\pm$ 0.01 ^g	0.57 $\pm$ 0.04 ^{g,i}
Magnesium (Mg, %)	0.12 $\pm$ 0.01 ^{b,i}	0.10 $\pm$ 0.01 ^{b,g}	0.48 $\pm$ 0.01 ^{g,i}
Total essential minerals (%)	13.70 $\pm$ 0.56 ^a	13.80 $\pm$ 0.31 ^a	13.11 $\pm$ 0.16 ^{a,c}
Trace Minerals			
Iron (Fe, mg/L)	23.90 $\pm$ 8.22 ⁱ	15.90 $\pm$ 5.99 ^g	60.70 $\pm$ 10.80 ^{g,i}
Manganese (Mn, mg/L)	0.35 $\pm$ 0.16 ⁱ	0.18 $\pm$ 0.06 ^g	2.41 $\pm$ 0.24 ^{g,i}
Copper (Cu, mg/L)	16.80 $\pm$ 3.32 ^{h,i}	5.18 $\pm$ 0.74 ^{e,h}	6.92 $\pm$ 0.47 ^e
Zinc (Zn, mg/L)	8.31 $\pm$ 5.43 ⁱ	4.74 $\pm$ 1.28 ^g	27.30 $\pm$ 1.35 ^{g,i}
Total of trace minerals (mg/L)	49.40 $\pm$ 17.13 ^{e,i}	26.00 $\pm$ 8.06 ^{e,g}	97.30 $\pm$ 12.90 ^{g,i}

^{a,b,c} significant difference between types of egg at $p < 0.05$
^{d,e,f} significant difference between type of eggs at $p < 0.01$
^{g,h,i} significant difference between type of eggs at $p < 0.001$

Table 3 Moisture and Minerals of chicken, quail and snail-eating turtle egg yolks

Parameters	Chicken Mean $\pm$ S.D.	Quail Mean $\pm$ S.D.	Snail-eating turtle Mean $\pm$ S.D.
Moisture (%)	49.80 $\pm$ 0.25 ^{e,i}	52.16 $\pm$ 0.56 ^{e,g}	58.30 $\pm$ 1.68 ^{g,i}
Essential Minerals			
Nitrogen (N, %)	5.11 $\pm$ 0.11 ⁱ	5.01 $\pm$ 0.10 ^g	9.02 $\pm$ 0.00 ^{g,i}
Phosphorous (P, %)	0.09 $\pm$ 0.00 ^{b,i}	0.92 $\pm$ 0.01 ^{b,g}	1.22 $\pm$ 0.03 ^{g,i}
Potassium (K, %)	0.26 $\pm$ 0.03 ^{b,i}	0.31 $\pm$ 0.00 ^{b,g}	0.43 $\pm$ 0.01 ^{g,i}
Calcium (Ca, %)	0.27 $\pm$ 0.01 ⁱ	0.27 $\pm$ 0.00 ^g	0.44 $\pm$ 0.01 ^{g,i}
Magnesium (Mg, %)	0.03 $\pm$ 0.00 ^{h,i}	0.04 $\pm$ 0.00 ^{g,h}	0.07 $\pm$ 0.00 ^{g,i}
Total essential minerals (%)	6.57 $\pm$ 0.16 ⁱ	6.55 $\pm$ 0.11 ^g	11.17 $\pm$ 0.05 ^{g,i}
Trace Minerals			
Iron (Fe, mg/L)	88.00 $\pm$ 10.91 ^{e,i}	116.00 $\pm$ 2.53 ^{e,g}	33.90 $\pm$ 2.41 ^{g,i}
Manganese (Mn, mg/L)	1.20 $\pm$ 0.21 ^c	1.20 $\pm$ 0.06 ^a	1.62 $\pm$ 0.06 ^{a,c}
Copper (Cu, mg/L)	19.70 $\pm$ 4.04 ^{b,f}	26.90 $\pm$ 1.86 ^{b,g}	3.25 $\pm$ 1.14 ^{f,g}
Zinc (Zn, mg/L)	70.20 $\pm$ 1.18	70.60 $\pm$ 1.94	70.10 $\pm$ 0.93
Total of trace minerals (mg/L)	179.10 $\pm$ 16.35 ^{e,i}	215.00 $\pm$ 6.40 ^{e,g}	108.80 $\pm$ 4.54 ^{g,i}

^{a,b,c} significant difference between types of egg at $p < 0.05$
^{d,e,f} significant difference between type of eggs at $p < 0.01$
^{g,h,i} significant difference between type of eggs at $p < 0.001$

In addition, snail-eating turtle egg yolk was significantly higher in total essential mineral level (11.17 mg/L) than those of the chicken (6.57 mg/L, $p < 0.001$) and quail egg yolks (6.55 mg/L, $p < 0.001$). Most of essential minerals in all egg yolks were nitrogen. Whilst total trace mineral level of quail egg yolk (215.00 mg/L) was significantly higher than those of the chicken (179.10 mg/L, $p < 0.01$) and snail-eating turtle egg yolks (108.8 mg/L, $p < 0.001$) (Table 3). Most of trace minerals, of chicken and quail egg yolks was iron but of snail-eating turtle was zinc.

DISCUSSION

In whole eggs, the most minerals of chicken, quail was iron (64.20% & 80.80%), while zinc (68.70%) was found in the snail eating-turtle egg. These minerals (iron and zinc) were trace minerals which benefit for health. For egg whites of chicken, quail

and snail eating-turtle eggs, there were essential minerals contents in the same range of levels but trace minerals were the highest levels of iron, and zinc in snail-eating turtle while the copper was highest in chicken. Total of essential minerals was highest in quail but total of trace minerals was highest in snail-eating turtle. For egg yolks, snail-eating turtle was higher nitrogen content than chicken and quail. As of this result, total essential mineral was highest (11.17%). While iron and copper were highest in quail, as of this result total trace mineral was highest in quail egg (215.00 mg/L).

Our results demonstrated that the essential minerals were found in all types of egg. The total content was highest in snail-eating turtle but total trace minerals was highest in quail which mainly found in egg yolks. These high mineral levels of quail egg supported the previous study done by Ono and

Wakasugi [36]. The variation of mineral eggs may involve the amount of genetic variants of a number of yolk proteins [37] and binding capacity of mineral in their eggs [38]. The enrichment of iron in egg would provide improving the nutrition status of people especially in the risk of iron deficiency or anemia group. In general population, there are several groups of people are at risk of iron deficiency such as infant, children, pregnant women and socioeconomic groups [39-43]. So, enriching the iron content of eggs may be useful strategy with low economic cost which is available for all people at risk of iron deficiency. The importance of iron nutrition is recognized in the context of child nutrition, fortification, and biofortification, and it is likely that meaningful advances will be made through these initiatives in the coming decade [44]. In addition, the enrichment of zinc would be benefit for reduction of diarrhea and pneumonia mortality in children [45, 46].

CONCLUSION

The snail-eating turtle egg was source of both essential minerals of nitrogen, phosphorous, calcium, magnesium and trace minerals of manganese and zinc. Quail egg was a source of trace minerals especially iron as well as chicken egg as source of copper and iron.

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