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Comparison of Quality and Nutritional Components of Eggs from Blue Peafowl and Hen

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Abstract The study was undertaken to compare the quality and nutritional components of eggs from blue peafowl and Jingbai hen. The results showed that the average egg weight, eggshell thickness and egg yolk relative weight of blue peafowl eggs were significantly bigger than those of hen eggs ($p < 0.01$). Blue peafowl eggs contained significantly higher protein ($p < 0.01$), higher carbohydrate ($p < 0.01$), total amino acid and essential amino acid ($p < 0.01$), Zn ($p < 0.01$), Ca ($p < 0.05$) but lower fat ($p < 0.01$) and water ($p < 0.05$) than those in hen eggs. Amino acid content of blue peafowl eggs was in accordance with the ideals of the FAO mode. Blue peafowl eggs contained significantly higher V_C and V_{B2} ($p < 0.01$) but lower V_A and V_E ($p < 0.01$) than hen eggs. 47 volatile compounds were found in raw blue peafowl eggs while only 30 in raw hen eggs; 60 volatile compounds were found in cooked blue peafowl eggs while only 41 in cooked hen eggs. Overall, most indices of qualities and nutrient components of blue peafowl eggs were not inferior to hen eggs.

Keywords: *blue peafowl egg, hen egg, composition, nutritional quality*

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1. Introduction

Blue peafowl (*Pavo cristatus*), known as phoenix. In most countries, blue peafowl is a kind of special poultry for viewing and admiring. Now they are raised in most of countries. Wild green peafowl is listed as the national first-class protected animals in China, while home-raised blue peafowl is not included, so they can be raised for food. The blue peafowl can averagely produce 30 eggs a year, and each egg is 90-120 grams.

Eggs are widely used as ingredient in food industry because of their nutritional, functional and good sensory qualities. Egg quality includes outside quality and inside quality. Outside quality contains egg weight, egg shape index, egg shell thickness, ratio of protein and ratio of egg yolk, etc. Inside quality is always evaluated with Haugh unit, protein height, egg pH, and egg specific gravity, etc. Egg nutrition includes crude protein, fat, cholesterol, moisture, and so on. Since each kind of bird has different genetic background, their egg qualities and nutrition components are variable. Generally, egg shape index, eggshell weight, yolk color and ratio in local hens were better than those in commercial chicks [1]. Egg quality of Hy-line brown was better than that of Jingbai hen, but nutrient content of Hy-line brown was lower than hen [2]. The protein, phosphatide and amino acid of hen eggs are lower than those of dark eggs and quail eggs [3]. As a matter of fact, egg qualities and nutrition components from same species may vary significantly as a result of differences in breed, feed, feeding way, growing environment [4-9].

Blue peafowl eggs can be used for food, but its quality and nutrient components has not been reported. The aim of this research was therefore to evaluate the quality and nutrient components of blue peafowl eggs. Jingbai eggs, widely consumed in most Chinese dishes, were taken as control for comparison. The results could provide reference for people to choose reasonable nutrition, and also offer theoretical basis for the food processing and utilization of blue peafowl genetic resources.

2. Materials and Methods

2.1. Blue Peafowl Eggs and Jingbai Hen Eggs

Total of 100 fresh eggs were produced by blue peafowls aged at four years, randomly collected less than 24 h after laying (Gansu Hongxiang blue peafowl high-tech agricultural development Co. Ltd). Total of 100 fresh Jingbai hen eggs were randomly obtained from local chicken farm. Egg samples were stored for 24 h at room temperature before measurements were performed.

2.2. Egg Quality Analysis

Each egg was initially weighed using an Egg Analyzer (ORKA Food Technology Ltd., Ramat Hasharon, Israel). Length and width diameters of eggs were measured using vernier caliper, and egg shape index were calculated according to formula (egg shaped index = length diameter / width diameter). Eggshell thickness was a mean of measurements taken at three locations on the egg (air cell, equator, and sharpend) with an EggShell Thickness Gauge (ESTG-1, ORKA Food Technology Ltd., Ramat Hasharon, Israel). The saturated solution floating method was used to test egg specific gravity. That is, the concentrations of saline were gradually increased from 1.068-1.100 $g·mL^{-1}$ by a gradient of 0.004 $g·mL^{-1}$. The minimal saline concentration in which eggs can be freely floated on was regarded as egg specific gravity. Then, the egg was broken, and the egg's contents (albumin and yolk) were placed on the measuring tray of the Egg Analyzer for the automatic determination of egg yolk height and albumen height [10]. The Haugh unit was calculated as 100 log ($H + 1.7W^{0.37} + 7.6$), where H is the albumen height (mm) and W is the weight of the egg (g). After Haugh gauge unit measurement finished, both egg yolk and album were together transferred into a glass beaker and homogenized for pH measurement, and whole egg pH was measured by precision pH-meter (MP512-03, Shanghai Shenke Instrument Co., Ltd.).

2.3. Nutrient Contents Analysis

Egg nutrients include general nutrient, mineral elements, amino acid, vitamin and volatile compounds. General nutrient tested included moisture, crude protein, crude fat and cholesterol. Mineral elements were Ca, Zn, Fe, Mn, Cu, P, K and Na. Vitamin included Vitamin A (abbreviated as V_A), Vitamin B_1 (V_{B1}), Vitamin B_2 (V_{B2}), Vitamin C (V_C) and Vitamin E (V_E). Eighteen kinds of amino acids were found in blue peafowl eggs. They all were analyzed according to National Food Safety Standards of P.R. China (abbreviated as GB/T). For example, the moisture was determined according to GB/T 5009.3-2003.

Generally, nutrition value was evaluated by essential amino acid requirement model that the United Nations Food and Agriculture Organization (FAO) recommended in 1981, which was calculated with the formula as below:

$$\text{Amino acid score} = \frac{\text{Amino acid content of per gram protein to be tested } (te)}{\text{Amino acid content of per gram ideal mode or refer protein } (ro)} \times 100$$

2.4. Volatile Compounds Analysis

Analyses were performed using a gas chromatography (model 6890, Hewlett-Packard Company, Palo Alto, USA), which was fitted with a splitless injector and Agilent 5973 mass spectrometer (MS) detector (Agilent Technologies, Santa Clara, USA). The components were separated on a SPB-5 capillary column 60 m × 0.32 mm × 1.0-µm-film thickness, (Supelco, Bellefonte, PA).Helium was used as the carrier gas with a flow rate of 20 mL/min. The injector temperature was 250°C. The temperature was programmed at 50°C for 2 min, raised from 50°C to 270°C by a rate of 3°C/ min, and held constant at 270°C for 10 min. Detection was carried out by MS on the total ion current obtained by electron impact at 70 eV. Ion source temperature was 200°C. Scan range was from 30 to 500 amu.

Compounds were identified with NIST 98 data bank (NIST/EPA/NISH Mass Spectral Library, version 1.6, U.S.A.), using a match factor higher than 97% and also by comparison of their GC Kovats index and in some cases by comparison of their retention times with those of standard compounds.

The relative content of volatile flavor compounds was quantitatively determined by peak area normalization method.

2.5. Statistical Analysis

All the measurements were carried out in triplicate; the values were averaged and reported along with their standard deviation (S.D). Data were analyzed with paired *t* test. Probabilities lower than 0.01 were considered as statistically highly significant ($p < 0.01$). Probabilities lower than 0.05 were considered as statistically significant ($p < 0.05$). All statistical calculations were performed with the SPSS 13.0 statistical software for Windows.

3. Results and Discussion

3.1. Egg Quality Characteristics

Quality indexes of blue peafowl and hen eggs are shown in Table 1. Egg weight, egg yolk index, egg protein relative weight, egg yolk relative weight and eggshell thickness were significantly different ($p < 0.01$) between two species eggs, while egg shape index, eggshell relative weight, ratio of egg yolk and egg protein, Haugh unit, whole egg pH and egg specific gravity were not significantly different ($p > 0.05$).

Table 1. Quality indexes of blue peafowl and hen eggs ($\bar{x} \pm s$, n=3)

Indexes	Blue peafowl	Jingbai hen	p-value
Egg weight (g)	94.400±4.681	48.531±3.183	**
Egg shape index	1.337±0.046	1.322±0.051	*NS*
Egg yolk index	0.445±0.151	0.693±0.123^B	**
Egg protein relative weight (%)	43.409±2.617	60.041±2.260^B	**
Egg yolk relative weight (%)	42.993±2.815	28.752±1.883	**
Eggshell relative weight (%)	13.598±0.712	12.294±0.432	*NS*
Ratio of egg yolk and protein (%)	99.879±12.141	87.466±9.786	*NS*
Haugh unit (Hu)	74.033±2.534	72.601±6.420	*NS*
Whole egg pH	7.120±1.852	7.062±0.887	*NS*
Egg specific gravity (g/cm^3)	1.095±0.043	1.087±0.005	*NS*
Eggshell thickness (mm)	0.488±0.004	0.363±0.041	**

**$p < 0.01$; *$p < 0.05$; NS $p \geq 0.05$.

Egg weight is largely determined by genetic factors, as well as poultry weight, age at first egg, temperature and feed nutrition [11]. Blue peafowl average egg weight is (94.400±4.681) g, significantly higher than hen egg

(48.531±3.183) g. The main reason of this difference is due to the genetic factors.

Egg shape index influenced hatchability [12,13], which is one of the indicators for classifying avian species. A particular kind of avian species tend to have certain egg-shaped index. Normal egg index is generally about 1.29 ~ 1.39 [14]. The blue peafowl egg index was 1.34±0.046, being considered in the normal range.

Egg specific gravity could reflect the freshness of egg, and it also associated with shell thickness [15]. Normal egg specific gravity is in the range 1.06 ~ 1.10 g/cm^3, and the egg specific gravity of good quality egg is bigger than 1.08 g/cm^3. The blue peafowl eggs specific gravity was (1.095±0.043) g/cm^3, denoting its quality was better than that of hen eggs. Blue peafowl eggshell thickness was thicker than that of hen eggs (p < 0.01), which was more advantageous in transportation and storage.

Ratio of egg yolk and whole egg has great influence on nutrients content of egg. Egg yolk nutrients are more complex than egg protein, which has more rich nutrition [16]. In this study, blue peafowl egg yolk accounted for 42.99% of whole egg, 14.24% higher than that of hen egg; the ratio of egg yolk and protein reached up to 99.88%, 12.41% higher than hen eggs, these results indicated blue peafowl egg nutritional value was higher than hen egg.

Haugh unit is one of the egg quality category standard set by United States Department of Agriculture [10], Haugh unit is greater than 72 to AA grade, greater than 55 or less than 71 to A grade, less than 60 to B grade. Grade AA and A eggs are edible eggs, while B level is not suitable to eat. The Haugh unit of blue peafowl egg was 74.033±2.534, which showed that blue peafowl egg protein quality was good than that of hen egg.

3.2. General Nutrient

Table 2. Nutrient contents in blue peafowl and hen eggs (g/100g, $\bar{x} \pm s$, n=3)

Samples	Blue peafowl	Jingbai hen	*p*-value
Moisture	65.231±3.433	73.202±2.885	*
Protein	15.554±0.076	12.602±1.007	**
Fat	0.923±0.002	10.501±0.879	**
Cholesterol	0.543±0.013	0.585±0.206	*NS*
Carbohydrate	16.982±0.044	1.501±0.018	**

**p < 0.01; *p < 0.05; NS $p \geq 0.05$.

Moisture, protein, fat, carbohydrate and cholesterol contents are shown in Table 2. The mean moistrure content of blue peafowl eggs was lower than that of hen eggs (p < 0.05), and lower to the value reported for duck (70.82%) [8,17], quail (70.60%) [3] and ostrich (75.1%) [18]. The protein, fat and carbohydrate content of two kinds of eggs differed significantly (p < 0.01), while the cholesterol content was found no significant (p > 0.05). The fat content of blue peafowl eggs was only (0.923±0.002) g/100 g, far lower than that of hen eggs (10.501±0.879) g/100 g, and lower than those of duck (10.5~12.21%) [8,17] (Zhou and others 2009; Wei and others 2012), quail (8.22%) [3] (Chen and others 2005) and ostrich (11.7%) [18]. The protein content of blue peafowl eggs was (15.554±0.076) g/100 g, higher than that of hen eggs (12.602±1.007) g/100 g, and those of duck (13.1%) [8,17], quail (14.73%) [3] and ostrich (12.2%) [18]. The carbohydrate content of blue peafowl eggs was higher than that of hen eggs. The cholesterol content of blue peafowl egg appeared similar to the value for hen egg (0.585±0.206) g/100 g but much lower compared to the value reported for black hen (0.612%) and quail (0.866%) [3].

The nutrient differences between two kinds of eggs, especially for protein\ fat and carbohydrate, may be caused by genetic background, feed, growing environment, etc. As a whole, blue peafowl egg was considered to be a kind of food with high protein, high carbohydrate and low fat compared to hen and other avian eggs.

3.3. Mineral

Table 3 presents the mineral element content of two kinds of eggs. Except for Na and Se, the content of P, K, Zn, Mn, Fe and Cu in the tested eggs differed significantly (p < 0.01). The blue peafowl eggs were found to contain a significantly (p < 0.05) higher Ca content but lower Fe content (p < 0.01) than those in hen eggs. It was observed that the blue peafowl eggs presented the highest (p < 0.01) Zn content but the lowest Cu content (p < 0.01) than that of hen eggs. The Zn content of blue peafowl eggs was 7 times than that of hen eggs, which indicated that blue peafowl eggs may be good food for people who lack of Zn in daily food.

Table 3. Mineral elements contents in blue peafowl and hen eggs (g/100g, $\bar{x} \pm s$, n=3)

Mineral	Blue peafowl	Jingbai hen	*p*-value
Ca	0.075±0.023	0.035±0.003	*
P	0.032±0.014	0.162±0.021	**
K	0.055±0.033	0.142±0.034	**
Na	0.198±0.107	0.058±0.025	*NS*
Zn	19.690±0.043	2.880±0.032	**
Se	0.060±0.061	0.017±0.003	*NS*
Mn	1.340±0.012	0.010±0.003	**
Fe	2.020±0.007	4.520±0.022	**
Cu	0.003±0.001	0.130±0.020	**

**p < 0.01; *p < 0.05; NS $p \geq 0.05$.

3.4. Amino Acid

Table 4. Amino acid contents of blue peafowl and hen eggs ($\bar{x} \pm s$, g/100g)

Amino acids	Blue peafowl	Jingbai hen	*p*-value
Thr*	0.63±0.026	0.61±0.007	*NS*
Val*	0.82±0.048	0.69±0.009	**
Met*	0.51±0.017	0.48±0.027	*NS*
Ile*	0.68±0.029	0.55±0.033	**
Leu*	1.09±0.021	1.03±0.008	**
Phe*	0.69±0.054	0.63±0.033	*NS*
Lys*	0.95±0.018	0.82±0.025	**
Trp*	0.15±0.003	0.16±0.01	*NS*
Asp#	1.27±0.025	1.26±0.027	*NS*
Ser	0.96±0.012	0.96±0.072	*NS*
Glu#	1.7±0.054	1.76±0.071	*NS*
Gly#	0.41±0.009	0.42±0.027	*NS*
Ala#	0.79±0.012	0.7±0.018	**
Tyr	0.58±0.015	0.47±0.030	**
His	0.31±0.016	0.28±0.035	*NS*
Arg#	0.77±0.034	0.77±0.026	*NS*
Pro	0.41±0.010	0.37±0.031	*NS*
Cys	0.32±0.022	0.27±0.014	*
TAA	13.04	12.23	**
EAA	5.52	4.97	**
EAA/TAA (%)	42.33	40.64	
EAA/NEAA (%)	73.40	68.46	
FAA	4.94	4.91	
FAA/TAA (%)	37.88	40.15	

**p < 0.01; *p < 0.05; NS $p \geq 0.05$. TAA=Total amino acids; *EAA=Essential amino acids; NEAA=Nonessential amino acids; #FAA=Flavor amino acids.

As shown in Table 4, there were 18 kinds of amino acids in blue peafowl eggs and hen eggs. Both of examined eggs were found to contain the highest Glu content (1.7 ± 0.054 and 1.76 ± 0.071 g/100 g, respectively). Greater Val, Ile, Leu, Lys, Ala and Tyr content (p < 0.01) were noticeable in the blue peafowl eggs compared to those in hen eggs. The Cys content of the blue peafowl eggs was twice times than that of hen eggs (p < 0.05). It was observed that the total amino acid (TAA) and essential acid (EAA) content in blue peafowl eggs reached 13.04 g/100 g and 5.52 g/100 g respectively, higher than those in hen eggs (p < 0.01). There was no significant difference in the content of flavor amino acids (FAA) including Asp, Glu, Arg, Ala and Gly between two kinds of eggs (p > 0.05).

3.5. Amino Acid Nutrition Value

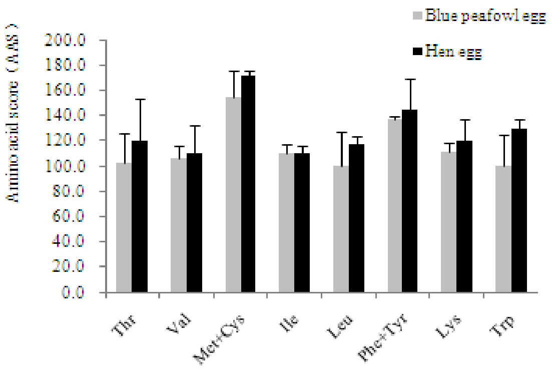

Figure 1. Comparison of essential amino acids in blue peafowl and hen eggs with FAO/WHO standard (mg/gN)

The FAO ideal mode is defined as amino acid supply of human body by the United Nations Food and Agriculture Organization (FAO) according to the amino acid structure proportion of eggs and milk. Figure 1 showed the essential amino acid scores (AAS) of blue peafowl eggs and hen eggs compared with the amino standard model set by the FAO.

The AAS of Ile was found to be similar in two kinds of eggs, while the AAS of other amino acids in blue peafowl eggs were lower than that of hen eggs. The AAS of Thr, Val, Leu and Lys in blue peafowl eggs were all closer to the ideal model. Among the AAS determined, Met+Cys were the highest in both two kinds of eggs.

3.6. Vitamin

Table 5 showed the contents of V_{B1}, V_{B2}, V_C, V_A and V_E in two kinds of eggs. The V_{B1}, V_C, V_A and V_E content of two kinds of eggs differed significantly (p < 0.01). The content of Vc in Jingbai eggs was not detect out, and it may attribute to low content.

Table 5. Vitamin contents in blue peafowl and hen eggs (mg/100g, $\bar{x} \pm s$, n=3)

Samples	Blue peafowl	Jingbai hen	p-value
V_{B1}	0.130±0.033	0.110±0.045	**
V_{B2}	0.410±0.003	0.270±0.006	*NS*
V_C	30.300±2.045	–	**
V_A	0.030±0.016	0.230±0.022	**
V_E	0.020±0.007	1.840±0.053	**

**p < 0.01; *p < 0.05; NS $p \geq$ 0.05.
-:not checked out.

3.7. Volatile Compounds

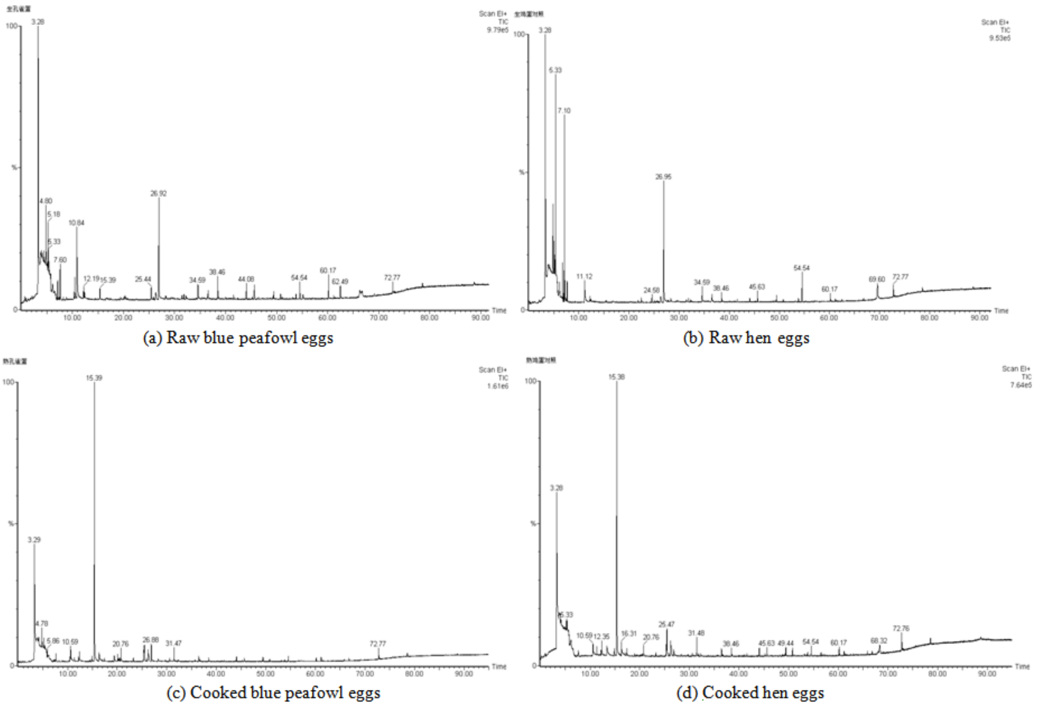

Figure 2. Total ionic flow chart of volatile compounds in blue peafowl and hen eggs

Each egg has its own characteristic volatile substances which exhibits its special flavor and odor. These compounds characterize not only eggs' quality but also taste. Gas chromatography analysis of the volatile compounds from blue peafowl eggs and hen eggs are shown in Figure 2. The volatile compounds in raw blue peafowl eggs and hen eggs are listed in Table 6.

Table 6. Volatile compounds in raw blue peafowl and hen eggs

Number	Time	Volatile Compounds	MF	Content (%) Blue peafowl	Hen
1	4.45	1,2-diethoxy-Ethane	$C_6H_{14}O_2$	12.00	-
2	4.84	2-methylpentane	C_6H_{14}	-	7.63
3	5.33	Hexane	C_6H_{14}	13.76	15.15
4	6.71	2-methylhexane	C_7H_{16}	-	2.55
5	7.60	Chloroform	$CHCl_3$	1.54	-
6	8.81	1,2-dichloro-Ethane	$C_2H_4Cl_2$	0.13	-
7	10.46	Dimethoxymethane	$C_3H_8O_2$	1.24	-
8	45.26	Hendecane	$C_{11}H_{24}$	-	0.11
9	49.32	Pentadecane	$C_{15}H_{32}$	0.11	0.24
10	51.09	1-chloro-Tetradecane	$C_{14}H_{29}Cl$	0.14	-
11	56.84	n-Hexadecane	$C_{16}H_{34}$	0.03	0.14
12	60.18	Cyclooctane	C_8H_{16}	1.31	-
13	72.76	Eicosane	$C_{20}H_{42}$	1.05	2.03
14	5.09	4-Methyl-1-hexene	C_7H_{14}	-	2.14
15	6.12	2-methyl-1-pentene	C_6H_{12}	-	2.37
16	12.36	Cycloheptatrien	C_7H_8	0.37	-
17	19.41	Cinnamene	C_8H_8	0.15	-
18	39.90	Myrcene	$C_{10}H_{16}$	0.10	0.45
19	15.40	Hexanal	$C_6H_{12}O$	0.71	0.17
20	20.78	Heptaldehyde	$C_7H_{14}O$	0.08	-
21	26.34	Benzaldehyde	C_7H_6O	1.17	1.76
22	31.48	Nonenal	$C_9H_{18}O$	0.29	0.35
23	36.48	Decanal	$C_{10}H_{20}O$	0.25	0.37
24	40.18	(z)-3,7-dimethylocta-2,6-dienal	$C_{10}H_{16}O$	0.08	-
25	41.19	Octanal	$C_8H_{16}O$	0.04	0.84
26	41.58	(E)-3,7-dimethylocta-2,6-dienal	$C_{10}H_{16}O$	0.21	
27	45.63	Dodecanal	$C_{12}H_{24}O$	0.92	-
28	53.81	Undecanal	$C_{11}H_{22}O$	0.27	-
29	61.17	hexadecanal	$C_{16}H_{32}O$	0.13	0.67
30	5.19	Acetone	C_3H_6O	5.74	0.73
31	7.42	2-butanone	C_4H_8O	0.12	0.30
32	20.53	2-heptanone	$C_7H_{14}O$	0.10	-
33	49.43	2-Tridecanone	$C_{13}H_{26}O$	0.37	-
34	4.81	Ethyl alcohol	C_2H_6O	15.65	-
35	10.27	1-Butanol	$C_4H_{10}O$	0.39	-
36	20.09	1-hexanol	$C_6H_{14}O$	0.12	-
37	25.69	Cineole	$C_{10}H_{18}O$	-	0.21
38	28.24	2-Ethyl hexanol	$C_8H_{18}O$	0.14	-
39	32.26	Benzyl alchol	C_7H_8O	0.32	0.45
40	34.20	6-amino-2-methyl-2-heptanol	$C_8H_{19}ON$	0.08	-
41	38.46	3,7-dimethyl-6-octen-1-ol	$C_{10}H_{20}O$	1.34	1.05
42	3.28	Ethyl L-Alaninate	$C_5H_{11}O_2N$	30.06	26.06
43	7.12	exanoic acid ethyl ester	$C_4H_8O_2$	0.80	13.76
44	46.43	Butyl isobutyrate	$C_8H_{16}O_2$	0.14	-
45	88.71	1,2-Benzenedicarboxylic acid, dioctyl ester	$C_{24}H_{38}O_4$	0.32	-
46	10.86	Acetic acid	$C_2H_4O_2$	6.78	4.60
47	29.34	Hexanoic acid	$C_6H_{12}O_2$	0.21	-
48	8.21	Benzeen	C_6H_6	0.13	0.10
	12.36	Toluene	C_7H_8	-	0.53
49	17.42	1,2-Xylene	C_8H_{10}	0.09	0.30
50	17.01	Ethyl benzene	C_8H_{10}	0.10	-
51	46.19	2-methoxy-4-(1-propenyl)-Phen ol	$C_{10}H_{12}O_2$	0.05	-
52	88.71	Dimethylbenzene	$C_{24}H_{38}O_4$	-	0.34
53	5.73	Tuaminoheptane	$C_7H_{17}N$	-	0.64
54	25.44	Tetrahydro-2,6-dimethoxy-dimethoxy-2H-Pyran	$C_7H_{14}O_3$	0.71	-
55	28.35	1,3-Dioxolane	$C_3H_6O_2$	0.19	-
56	40.19	N-(Oxidiethylene)-2-benzothiazolyl sulfenamide	C_7H_5NS	-	0.14

-: not checked out.

Table 7. Volatile compounds in cooked blue peafowl and hen eggs

Number	Time	Volatile Compounds	MF	Content(%) Blue peafowl	Hen
1	5.33	Hexane	C_6H_{14}	-	1.03
2	7.60	Chloroform	CHC_{l3}	0.78	-
3	8.81	1,2-dichloro-Ethane	$C_2H_4C_{l2}$	0.05	-
4	40.97	Hen decane	$C_{11}H_{24}$	0.06	0.10
5	11.35	Octane	C_8H_{18}	0.25	1.40
6	45.26	Tridecane	$C_{13}H_{28}$	0.08	-
7	53.17	Tetradecane	$C_{14}H_{30}$	0.08	0.58
8	56.83	Pentadecane	$C_{15}H_{32}$	0.07	-
9	60.31	Hexadecane	$C_{16}H_{34}$	0.06	-
10	72.76	Eicosane	$C_{20}H_{42}$	1.25	2.13
11	78.56	Hexatriacontane	$C_{36}H_{74}$	0.40	0.64
12	12.36	Tropiliden	C_7H_8	0.95	-
13	19.40	Cyclooctatetraene	C_8H_8	0.93	0.43
14	24.58	1-methyl-4-(1-methylethen yl)-Cyclohexene	$C_{10}H_{16}$	0.06	-
15	40.19	Myrcene	$C_{10}H_{16}$	-	0.08
16	8.90	3-methyl-Butanal	$C_5H_{10}O$	0.07	-
17	10.59	Pentanal	$C_5H_{10}O$	3.13	2.00
18	15.39	Hexanal	$C_6H_{12}O$	25.65	24.65
19	16.10	Octanal	$C_8H_{16}O$	0.17	0.05
20	20.76	Heptaldehyde	$C_7H_{14}O$	1.20	1.00
21	25.21	(E)-2-heptenal	$C_7H_{12}O$	0.22	-
22	26.24	Benzaldehyde	C7H6O	2.44	3.50
23	30.58	(E)-2-octenal	$C_8H_{14}O$	0.48	-
24	31.48	Nonenal	$C_9H_{18}O$	1.29	1.64
25	35.69	(E)-2-nonenal	$C_9H_{16}O$	0.07	-
26	36.47	Decanal	$C_{10}H_{20}O$	0.51	0.74
27	41.58	(E)-3,7-dimethyl-2,6-octadienaldehyde	$C_{10}H_{16}O$	0.17	0.31
28	43.88	(E,E)-2,4-decadienal	$C_{10}H_{16}O$	0.06	-
29	45.64	Undecanal	$C_{11}H_{22}O$	0.42	1.39
30	53.81	Dodecanal	$C_{12}H_{24}O$	0.17	-
31	57.59	Tedradecane	$C_{14}H_{28}O$	0.04	-
32	61.17	Hexadecanal	$C_{16}H_{32}O$	0.36	-
33	61.43	1,4-phthalic aldehyde	C_8H_6O2	0.10	-
34	5.18	Propanone	C_3H_6O	13.41	0.78
35	7.28	2,3-butanedione	$C_4H_6O_2$	0.07	-
36	7.40	2-butanone	C_4H_8O	0.15	0.15
37	20.52	2-heptanone	$C_7H_{14}O$	0.29	0.19
38	25.91	6-methyl-5-heptene-2-one	$C_8H_{14}O$	0.30	0.29
39	40.81	2-octanone	$C_8H_{16}O$	0.04	0.06
40	49.43	2-tridecanone	$C_{13}H_{26}O$	0.36	-
41	57.18	2-undecanone	$C_{11}H_{22}O$	0.09	0.70
42	4.78	Alcohol	C_2H_6O	10.24	-
43	6.11	Heptyl amineol	$C_8H_{19}ON$	-	2.02
44	10.27	Butanol	$C_4H_{10}O$	0.19	-
45	14.88	1-pentanol	$C_5H_{12}O$	0.64	0.78
46	20.06	1-hexanol	$C_6H_{14}O$	0.61	0.19
47	25.47	1-octen-3-ol	$C_8H_{16}O$	1.87	2.60
48	28.24	2-ethyl hexanol	$C_8H_{18}O$	0.27	-
49	30.58	Octanol	$C_8H_{18}O$	-	0.52
50	32.27	Benzyl alcohol	C_7H_8O	0.24	0.38
51	35.43	Heptanol	$C_7H_{16}O$	0.05	-
52	35.82	Phen ylethyl alcohol	$C_8H_{10}O$	0.02	-
53	38.47	Citronella oil	$C_{10}H_{20}O$	0.42	0.86
54	3.29	Ethyl L-Alaninate	$C_5H_{11}O_2N$	27.50	37.28
55	7.12	Ethyl acetate	$C_4H_8O_2$	0.16	-
56	37.50	Methyl salicylate	$C_8H_8O_3$	-	0.17
57	42.39	Acetic acid vanilla ester	$C_{12}H_{22}O_2$	-	0.07
58	65.85	Phthalic acid diisobutyl ester	$C_{16}H_{22}O_4$	0.14	0.35
59	69.12	Dibutyl-o-phthalate	$C_{16}H_{22}O_4$	0.09	0.24
60	8.22	Benzene	C_6H_6	0.12	0.12
61	12.36	Toluene	C_7H_8	-	1.40
62	17.02	Ethylbenzene	C_8H_{10}	0.18	0.23
63	17.41	O-xylene	C_8H_{10}	0.39	0.20
64	29.70	1-methyl-4-(1-methylethen yl)benzene	$C_{10}H_{12}$	0.16	-
65	32.52	Phen ol	C_6H_6O	0.04	-
66	13.39	Pyridine	C_5H_5N	-	3.02
67	23.26	2-pentylfuran	$C_9H_{14}O$	0.39	0.35
68	36.77	Azulene	$C_{10}H_8$	0.12	-

-: not checked out.

The volatile compounds in cooked blue peafowl eggs and hen eggs are listed in Table 7.

47 volatile compounds were found in raw blue peafowl eggs while only 30 in raw hen eggs; 60 volatile compounds were found in cooked blue peafowl eggs while only 41 in cooked eggs.

The cooked blue peafowl eggs contained higher aldehydes and ketones content than raw blue peafowl eggs, such as hexanal, heptaldehyde, nonenal, benzaldehyde, propanone, especially pentanal and 1-octen-3-alcohol were not detected out in raw blue peafowl eggs. On the contrary, the content and kinds of alkanes in cooked blue peafowl eggs were lower than raw blue peafowl eggs. Although we are not sure which kinds and amount of volatile substances are related to eggs' odor and taste, much more these compounds in peafowl eggs and different compounds in cooked and raw eggs are believed to be useful to evaluate two kinds of egg' quality. Further studies should be conducted under more controlled conditions to precisely analyze special characteristics of volatile odorous compounds from two kinds of eggs as well as cooked and raw eggs.

Most of the volatile compounds in cooked blue peafowl eggs were aldehydes (18), alcohol (10), ketones (8), alkanes (10), aromatic hydrocarbon (6). Aldehydes content were the highest, reached up to 36.55%, followed by ester accounted for 28.31% in cooked blue peafowl eggs; however, ester content was the highest, reached up to 38.97%, followed by aldehydes, accounted for 35.28% in cooked hen eggs.

4. Conclusion

Compared with Jingbai eggs, blue peafowl eggs had better qualities including egg-weight, eggshell thickness, egg-shape index, egg yolk index and Haugh unit. Blue peafowl eggs also possessed more advantages in nutrition owing to its higher carbohydrate and protein but lower fat and cholesterol, richer mineral element (Zn, Se, Mn and P), higher V_C, reasonable proportion of amino acids and much more volatile compounds than those in hen eggs. In a short, most indexes of qualities and nutrient components of blue peafowl eggs were superior to Jingbai hen eggs. It may be a good egg resource for consumers to choose.

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