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## Duck Production for Food Security

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**Abstract.** Poultry meat and eggs are one of the most widely consumed animal origin food in various parts of the world, across a wide variety of cultures, traditions and religions. In 2016 the duck population (*Anas spp.*) throughout the world reached 1.24 billion and 1.1 billion (89 percent) were in Asia. The production of meat and duck eggs is still lower than chickens, but ducks make a significant contribution in providing high-quality nutritional food needs. The consumption of duck eggs accounts for around 10-30% of total egg consumption in China and Southeast Asia. Duck eggs contain all essential amino acids required by the human diet and are a good source of vitamins and minerals. Due to lower water content, they are more nutrient than chicken eggs. Asian is the leading continent in duck meat production with a share of 82.2%, followed by Europe with 12.4%. Asia has also the highest increase of total and of per capita duck meat by 308% and 244%, respectively. Almost 10 percent of poultry meat in Asia is compared to 4.1% in the world. People consume the duck meat because of their high nutritional value with complete essential amino acid composition and good fatty acid composition with a high percentage of polyunsaturated fatty acids and a balanced ratio between omega-6 fatty acids and omega-3. Large-scale duck production requires more efforts for higher efficiency and improving product quality by breeding, nutrition and management in accordance with animal welfare requirements and environmental protection. Family duck farmers (small-scale production) with limited capital contribute significantly to food security, poverty alleviation, and the ecologically sound management of natural resources. Farmers must have more access to obtain good duck breed, appropriate technology, and service support, which can substantially increase productivity, income, and food security.

**Keywords:** duck, meat, egg, food security.

### 1. Introduction

Poultry meat and eggs are among the most consumed livestock-based food products around the world across cultures, traditions, and religions. Poultry meat and eggs consumption generally escalate during the past few decades. High demand is partly due to the growing population, urbanization, and income raise in developing countries. Chicken dominates meat consumption because it is affordable, low-fat, and popular across cultures, traditions, and religions. Poultry meat and eggs demand are predicted to continue to climb due to population growth and increased individual consumption. The poultry meat market is projected to expand regardless of the region or income rate, with slightly higher growth of income per capita in developing countries than developed counterparts. Poultry meat and eggs play a



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role in human nutrition by supplying high-quality, low-fat protein with an ideal fatty acid profile. Since the early 1960s, global egg consumption per capita has doubled, compared to five-fold in poultry meat. The highest growth is seen in Asia and Latin America. Between 2000 and 2030 poultry meat per capita demand is projected to increase by 271% in South Asia, 116% in Europe and Middle Asia, 97% in the Middle East and North Africa, and 91% in East Asia and the Pacific. Poultry is the primary source of animal protein around the world, seconded by pork. [1].

In Indonesia, local poultry, including duck, plays a crucial role in supplying animal-based animal protein. In 2017 poultry meat production reached 2,1 ton or 66,34% all meat production, and total eggs produced was 2.090 tons. Duck belongs to *Anas* and *Cairinagenus*. Most ducks are the offspring of mallard (*Anas platyrhynchos*) domesticated in South China. Duck is a crucial food source in the rural area in Asia, particularly South East Asia. Muscovy duck (*Cairina moschata*) domesticated in Latin America have spread around archipelagic countries in Africa and Asia, mainly in South East Asia. Muscovy is adaptable to the environment because it can survive with scarce water.

Duck meat and eggs are a highly nutritious foodstuff. Duck meat is consumed because of its high nutrient content with an optimum essential amino acid, proper composition of fatty acid with high polyunsaturated fatty acid and a balanced ratio of omega-6 and omega-3. Duck meat is unique and tasty, easy to prepare and cook into various dishes. Duck eggs are mostly processed into salted eggs, thousand-year eggs (pidan) and balut as the gourmet heritage in several Asian countries Asia[2].

Ducks exhibit superiority in immunity against disease over the other poultry species. Ducks are resilient, easy to be mating, and they live in a colony, particularly in a wet area. The drawback of keeping ducks in confinement is high food waste due to the less-efficient duckbill shape; therefore, duck meat and eggs are more expensive than those of chicken.

In rice-producing countries, there is a synergy between duck and rice yield. The free-range ducks act as natural predators for insects and snails, and ducks also eat the post-harvest grains (rice). As a predator and producer of natural fertilizer, duck contributes to a higher harvest. In 2016 the global population of duck (*Anas* spp.) was 1,24 trillion where 1,1 trillion alone is in Asia (89%). The biggest duck population is in China, Vietnam, Indonesia, Malaysia, and Bangladesh as presented in Figure 1 [1].

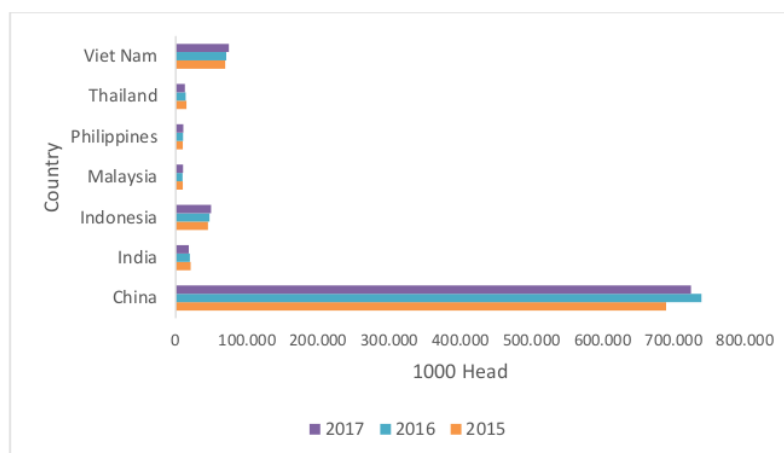


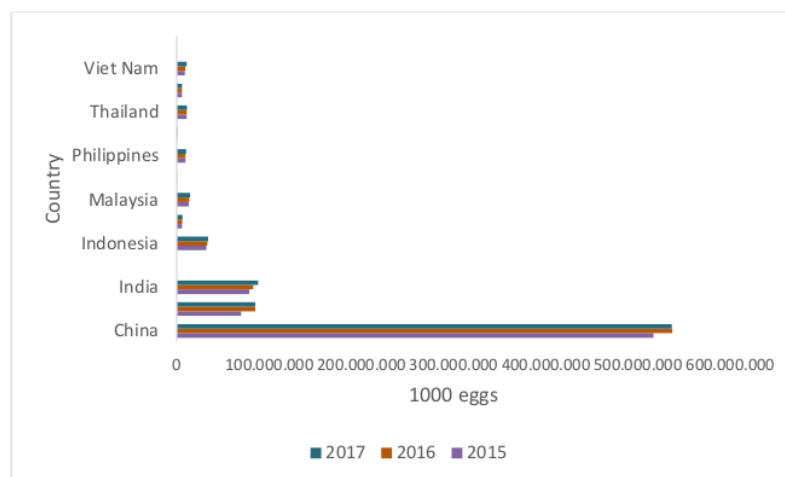
Figure 1. Duck population in Asian countries

## 2. Development Of Duck Egg Production

The accurate statistical data on duck egg production is not available. Food and Agriculture Organization of the United Nations (FAO) classifies egg production into two categories: “eggs, other

bird, in shell” that include eggs from duck, swan, guinea poultry, quail, turkey and other poultry (**Figure 2**), and “eggs, hen, in shell” that include chicken eggs (Table 3). In many cases, the statistic equals an estimation, and not all countries report the other poultry eggs such as India and Vietnam. Duck eggs fall into ‘other poultry egg’ category in statistical data, especially in Asian countries [3, 4].

It is also estimated that duck egg consumption accounts for 10–30% of total egg consumption in China and Southeast Asia [2]. Mainland China is the world’s top producer of other bird eggs in the shell, accounting for 77% of world production in 2013 [5]. In China, 80% of the total egg production is from chickens, the rest primarily from ducks and quail [6]. Overall, Asia accounted for 94% of world production in 2013. Higher figures for 2013 versus the 10-year average indicate that production is growing.



**Figure 2.** Chicken eggs and other poultry eggs production in Asian countries

In Indonesia total egg production in 2017 was 2.1 million ton consisted of 0.2 m ton local chicken eggs; 1.5 m ton layer eggs; 0.3 m duck eggs; 0.03 m ton quail eggs and 0.04 m ton Manila duck. The biggest egg production was from layer eggs (72.07%) followed by 14.48% duck eggs, 10.57% chicken eggs, 16.8% Manila duck eggs, and 1.20% quail eggs. Compared to the previous year, total egg production increased by 2.89% including local chicken eggs (12.35%), layer eggs (1.38%), duck eggs (3.65%), quail eggs (6.14%), and Manila duck eggs (5.63%) [7]. Duck eggs production is derived from different local ducks mostly in Java (Tegal duck, Magelang duck, and Mojosari duck), South Kalimantan (Alabio duck) and Bali (Bali duck) as presented in **Table 1** and **Table 2**.

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**Table 1.** Egg production and quality of Tegal, Magelang and Mojosari ducks in duck farming centers in Java island

Variables	Tegal duck	Magelang duck	Mojosari duck
Egg production (%)	70.890±6.410 <sup>a</sup>	70.240±4.100 <sup>a</sup>	74.090±6.190 <sup>b</sup>
Egg weight (g)	71.142±6.077 <sup>b</sup>	69.192±4.053 <sup>a</sup>	71.231±4.535 <sup>b</sup>
Albumen weight (g)	34.179±4.268 <sup>a</sup>	32.768±3.421 <sup>a</sup>	34.410±4.058 <sup>a</sup>
Egg yolk weight (g)	27.022±2.992 <sup>b</sup>	24.474±2.748 <sup>a</sup>	26.374±2.248 <sup>b</sup>
Shell thickness (mm)	0.379±0.021 <sup>a</sup>	0.381±0.021 <sup>a</sup>	0.399±0.037 <sup>a</sup>
Egg yolk color	7.200±0.969 <sup>ab</sup>	6.98±0.654 <sup>a</sup>	7.800±0.768 <sup>b</sup>
HU	78.041±6.077 <sup>b</sup>	78.346±6.867 <sup>b</sup>	71.015±8.485 <sup>a</sup>

Note: Values bearing different superscript within row show a significant difference in HSD test ( $P < 0.05$ ) [8].**Table 2.** Average egg production and quality of Alabio duck and Bali duck in duck farming center in Denpasar and Sungai Hulu Utara

Variables	Alabio duck	White Bali Duck	Brown, black and brown-black-white Bali Duck
Egg production (%)	72.890±6.410 <sup>b</sup>	60.240±8.100 <sup>a</sup>	70.090±6.190 <sup>b</sup>
Egg weight (g)	65.737±4.495 <sup>a</sup>	66.700±3.701 <sup>a</sup>	69.000±4.702 <sup>a</sup>
Haugh unit	78.062±6.450 <sup>b</sup>	74.272±4.568 <sup>a</sup>	74.864±6.882 <sup>a</sup>
Albumen weight (g)	33.529±3.759 <sup>b</sup>	31.420±3.530 <sup>a</sup>	32.340±4.019 <sup>a</sup>
Egg yolk weight (g)	23.549±1.433 <sup>a</sup>	28.263±2.117 <sup>b</sup>	27.528±3.061 <sup>b</sup>
Eggshell thickness (mm)	0.429±0.042 <sup>a</sup>	0.509±0.046 <sup>b</sup>	0.412±0.021 <sup>a</sup>
Egg yolk color	14.882±0.325 <sup>b</sup>	10.530±1.681 <sup>a</sup>	9.736±2.202 <sup>a</sup>

Note: Values bearing different superscript within row show significant difference in HSD test ( $P < 0.05$ ) [8].

Duck eggs are typically larger than chicken eggs, but characteristics vary by breed. Duck eggs contain all essential amino acids required in the human diet and are a good source of vitamins and minerals (Table 3). Due to lower water content, they are more nutrient-dense than chicken eggs.

**Table 3.** Comparison of nutrient Composition of Whole, Fresh, Raw Duck, and Chicken Eggs

Breed			Duck Egg	Chicken Egg
Nutrient	Unit		Value per 100 g <sup>a</sup>	Value per 100 g <sup>a</sup>
<b>Proximates</b>				
Water	g		70.83	76.15
Energy	kcal		185	143
Protein	g		12.81	12.56
Total lipid	g		13.77	9.51
Ash	g		1.14	20.6
Carbonhydrate, by difference	g		1.45	0.72
Fiber, total dietary	g		0	0
Sugar, total	g		0.93	0.37
<b>Minerals</b>				
Calcium, Ca	mg		64	56
Iron, Fe	mg		3.85	1.75
Magnesium, Mg	mg		17	12
Phosphorus, P	mg		220	198
Potassium, K	mg		222	138
Sodium, Na	mg		146	142

33	Vitamins	46	Zinc, Zn	mg	1.41	1.29
			Copper, Cu	mg	0.062	0.072
			Manganese, Mn	mg	0.038	0.028
			Selenium, Se	µg	36.4	30.7
26	Lipids	29	Vitamin C, total ascorbic acid	mg	0	0
			Thiamin	mg	0.156	0.040
			Riboflavin	mg	0.404	0.457
			Niacin	mg	0.200	0.075
			Pantothenic acid	mg	1.862	1.533
			Vitamin B-6, pyridoxine	mg	0.25	0.17
			Folate, total	µg	80	47
			Folic acid	µg	0	0
			Folate, food	µg	80	47
			Folate, dietary folate equivalent	µg	80	47
			Choline, total	mg	263.4	293.8
			Betamine	mg	0	0.3
			Vitamin B-12	µg	5.40	0.89
			Vitamin A, retinol activity equivalent	µg	194	160
			Retinol	µg	192	160
			Carotene, beta	µg	14	0
			Carotene, alpha	µg	0	0
			Cryptoxanthin, beta	µg	12	9
			Vitamin A	IU	674	540
			Lycopene	µg	0	0
		35	β-carotene + Zeaxanthin	µg	459	503
			Vitamin E, alpha-tocopherol	mg	1.34	1.05
			Vitamin E, added	mg	0	0
			Tocopherol, beta	mg	-	0.01
			Tocopherol, gamma	mg	-	0.5
		48	Tocopherol, delta	mg	-	0.06
			Vitamin D (D2 + D3)	µg	1.7	2.0
			Vitamin D3, cholecalciferol	µg	1.7	2.0
			Vitamin D	IU	69	82
			Vitamin K, Phylloquinone	µg	0.4	0.3
26	Lipids		Fatty acids, total saturated	g	3.681	3.126
			Fatty acids, total monounsaturated	g	6.525	3.658
			Fatty acids, polyunsaturated	g	1.223	1.911
			Cholesterol	mg	884	372

IU, International unit[9].

Duck eggs play a crucial role in supplying animal protein and contribute to the economy of duck farming center. Duck eggs are mostly processed into salted eggs. The nutrient composition<sup>44</sup> of fresh and salted duck eggs is presented in Table 4. Duck eggs contain a higher fat as well as higher omega 3, omega 6, and omega 9 fatty acid than chicken eggs as shown in Table 5.



**Table 4.** The comparison of chemical properties of fresh and salted duck eggs

Sample	Composition (% fresh)				
	Water	Protein	Fat	Mineral	Salt
Fresh egg					
Whole egg	71.77 ± 0.78	11.8 ± 1.15	13.52 ± 0.14	1.17 ± 0.02	0.33 ± 0.00
White egg	87.72 ± 0.62	10.5 ± 0.14	0.03 ± 0.012	0.74 ± 0.01	0.39 ± 0.07
Egg yolk	43.51 ± 0.52	16.0 ± 0.48	37.25 ± 0.16	1.59 ± 0.11	0.45 ± 0.04
Salted egg (14 days)					
White egg	83.59 ± 0.68	9.55 ± 0.12	0.05 ± 0.014	4.04 ± 0.18	6.90 ± 0.20
Egg yolk interior	36.21 ± 2.44	17.6 ± 0.56	44.32 ± 1.40	2.20 ± 0.01	0.84 ± 0.15
Egg yolk exterior	20.05 ± 0.29	21.3 ± 0.65	53.71 ± 0.39	2.45 ± 0.09	0.87 ± 0.10

Source:[10].

**Table 5.** The comparison of fatty acid of fresh and salted duck eggs

Fatty acid (% total fatty acid)	Fresh eggs	Salted eggs	
		7-daycuring	14-day curing
C14:0	0.50	0.43	0.50
C16:0	27.2	26.8	27.5
C16:1n-7	2.25	2.24	2.66
C18:0	6.19	5.50	5.63
C18:1n-9	47.5	48.0	48.4
C18:2n-6	8.08	8.73	6.88
C18:3n-3	0.33	0.31	0.30
C20:2n-6	0.17	0.27	0.34
C20:4n-6 (ARA)	2.62	2.57	2.79
C22:4n-6	0.18	0.15	0.18
C22:5n-3	0.37	0.41	0.23
C22:5n-6	0.35	0.22	0.31
C22:6n-3 (DHA)	1.66	1.95	1.61
Saturated fatty acid	33.9	32.7	33.6
Unsaturated fatty acid	63.6	64.9	63.7

Source:[10].

### 3. Development of Duck Meat Production

Asia is the leading continent in duck meat production with a share of 82.2%, followed by Europe with 12.4%. Asia also has the highest increase of total and of per capita duck meat by 308% and 244%, respective. Ducks produce almost 10% of poultry meat in Asia compared with 4.1% in the world. Duck meat production in Africa and Latin America is very low, and the annual per capita production amounts only to 60 and 66 g and is decreasing to 83 and 64%, respectively [2]. The trend production of duck meat in Asia is presented in **Table 6**.

In Indonesia poultry meat play the biggest role among other livestock. Meat poultry production in 2017 was 2505.77k ton that included 486.32k ton beef and 475,51k ton other meats (**Figure 3**). Duck meat production was lower than local chicken (**Figure 4**)[7].

Duck meat is a popular poultry product; it is evidenced by the shifting consumers' preference from chicken to duck. Manila duck, Khaki Campbell, Peking duck, and the crossbreed have promising market potential, especially in Asian countries [12],[13]reported that skinless breast duck meat contains lower calorie(140 Cal vs165 Cal), lower fat (2.5g vs. 4g), and rich iron (5mg vs. 1 mg) as opposed to skinless chicken breast meat. Dried duck meat contains a lower water content and higher protein than other meat product. Dried skinless duck meat contains the highest amino acid, i.e. lysine

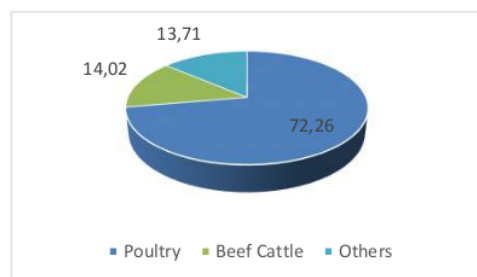


and leucine, followed by valine, threonine and isoleucine. Dried duck meat is a good source of iron, zinc, copper and manganese [14].

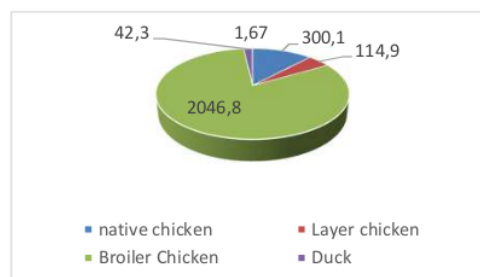
**Table 6.** The trend production of duck and chicken meat in Asian countries

Country	Species	2015	2016	2017
(tonnes)				
China	Chicken	12,629,971	13,406,286	13,440,444
	Duck	2,840,388	3,035,519	3,067,220
Indonesia	Chicken	2,030,884	2,300,767	2,258,239
	Duck	34,854	41,867	43,156
Malaysia	Chicken	1,511,442	1,653,913	1,648,491
	Duck	121,966	101,318	75,887
Philippines	Chicken	1,185,914	1,209,725	1,236,621
	Duck	33,940	33,313	32,829
Thailand	Chicken	1,620,791	1,580,354	1,616,785
	Duck	65,250	62,442	58,882
Viet Nam	Chicken	700,873	740,726	786,354
	Duck	122,318	127,280	131,502

Source:[11].



**Figure 3.** Meat production in Indonesia in 2017



**Figure 4.** Poultry meat production in Indonesia in 2017

Fat content in duck meat is higher than that of chicken, and turkey [15, 16], i.e. 1-2% on average[17], but *Anas platyrhynchos*, *Cairina moschata*, and the crossbreed demonstrates a relatively high-fat content around 2.26-7.57%[18]. In Indonesia, female local ducks to produce eggs are Tegal duck, Magelang Mojosari, Bali and Alabio, while the drakes are to produce meat. Another local duck with meat potential is Manila duck.

Different meat quality is partly due to breed or genetic factor. Meat quality is attributed to meat fat content (intramuscular fat), which affects physical and sensory properties and nutrient content. The meat of the Muscovy duck contains less fat than any other breed. Intramuscular fat content varies across poultry species as reported by [19] Peking duck and Muscovy have different intramuscular fat in different major pectoralis muscle (2.3% vs. 4.6%). Different fat content across waterfowls is due to lipase lipoprotein activity (LPL)[20]. The different balanced muscle lipogenesis and long-chain fatty acid oxidation as the precursor triacylglycerol synthesis is an important contributing factor to different levels of intramuscular fat across species [21] or within species [22].

Nutrient composition depends on duck genus and strain [23]. Analysis of variance showed that fat, cholesterol, and protein content of different local duck were relatively similar (**Table 7**). Muscovy

contains lower fat and protein than the other local ducks, but the cholesterol is the highest. It indicated that the duck genus did not affect meat nutrient. Skinless breast and thigh meat of local ducks contain a significantly lower fat than broiler, turkey, duck, and quail meat according to [24] (**Table 8**). Other studies reported that fat content in Muscovy and Peking duck breast meat was 2,8 g/100g and 6,4 g/100 g, respectively [25]. Indonesian local duck fed with 19% protein and 3000 kcal/kg ME produced meat with 6,16±1,29% fat and 186±0,13 mg/g cholesterol [26]. Different fat and cholesterol content are due to different feed offered. Fat and cholesterol synthesis in the cell through A coenzyme acetyl is affected by the fat and cholesterol content in the feed.

**Table 7.** The comparison of fat, cholesterol, and protein in the meat of Muscovy ducks and other local ducks.

Meat Chemical	Muscovy	Tegal	Magelang	Mojosari
Fat (%)	2.586±0.401	4.880±1.993	4.181±1.097	3.422±0.145
Cholesterol (mg/g)	1.249±0.098	1.078±0.088	1.034±0.143	1.007±0.259
Protein (%)	16.199±0.131	17.683±1.517	17.379±0.518	17.679±1.131

Source: [27].

**Table 8.** Chemical composition of fowl meat (g/100g)

Component	Broiler	Turkey	Ducks	Quail
Water	74.6	72.5	70.8	74.4
Ash	1	0.8	1.2	1.1
Protein	12.1	13.7	12.8	13.1
Fat	11.1	11.9	13.8	11.1
Carbohydrate	1.2	1.1	1.4	1.4

Source: [24].

**Table 9.** The comparison of fatty acid content in the meat of Muscovy duck and other local ducks

Methyl Ether Fatty Acid (%)	Muscovy	Tegal	Magelang	Mojosari
C8=0	0.154±0.060 <sup>ab</sup>	0.288±0.027 <sup>b</sup>	0.282±0.087 <sup>b</sup>	0.109±0.010 <sup>a</sup>
C12=0	0.154±0.020 <sup>ab</sup>	0.288±0.002 <sup>b</sup>	0.282±0.002 <sup>ab</sup>	0.109±0.016 <sup>a</sup>
C14=0	0.492±0.005	0.539±0.112	0.528±0.074	0.369±0.091
C16=0	22.847±0.601 <sup>b</sup>	22.848±3.211 <sup>b</sup>	19.351±3.621 <sup>ab</sup>	16.217±1.046 <sup>a</sup>
C16=1	2.439±0.010	2.107±0.207	2.346±0.153	1.890±0.862
C18=0	9.053±0.162 <sup>b</sup>	6.076±0.906 <sup>a</sup>	6.500±0.175 <sup>a</sup>	5.750±0.359 <sup>a</sup>
C18=1	36.223±0.219 <sup>b</sup>	28.250±5.120 <sup>ab</sup>	27.685±8.680 <sup>ab</sup>	22.443±3.396 <sup>a</sup>
C18=2	14.597±1.267 <sup>ab</sup>	13.963±2.022 <sup>ab</sup>	19.251±5.269 <sup>b</sup>	10.220±0.744 <sup>a</sup>
C18=3	0.124±0.007	-	-	-
C20=0	0.293±0.033 <sup>b</sup>	-	0.155±0.045 <sup>a</sup>	2.856±0.177 <sup>b</sup>
C22=0	3.154±0.060	3.495±0.328	2.715±0.636	2.493±0.010

Note: Values bearing different superscript within row show a significant difference ( $P < 0.05$ ) based on HSD test [27].

#### 4. Contribution of Duck Production for Food Security

The demand for duck meat and the egg-based product has continued climbing for the last 10 years. The increased consumption of duck meat demonstrated significant growth of duck farming, on the industry and small scale. In China and Asian countries, the growing population leads to increased consumption of duck-based foods. An intensive production system has been developed for the past 50

years through breeding, feeding, breeding management, and disease prevention and mitigation. In some countries, duck farming has been integrated with the parent stock, hatchery, farming duck, and product processing industry. Duck farming in the future is expected to grow in population, feed efficiency, and meat and egg production and low disease incidence [28]. An intensive duck farming for meat and egg should aim at improving quality through breeding, feeding, and management according to the required animal welfare and the environment condition. The standard feeding should follow the improved genetic potential. In a warm environment, a higher protein feed could not improve egg production because body heat increases due to the heat increment in protein digestion; therefore, protein synthesis for egg has depleted [29].

Consumers in developed countries are meticulous about product quality and production process. Intensive duck farming should consider animal welfare and environment protection [30]. Extensive duck farming in developing countries is dominated with small or house-hold scale farming, and some farmers provide a pond for the ducks. Ducks prefer open body of water/pond to nipple for drinking. In open water ducks' behavior is more active, and the body and plume condition is improved [31-33]. In some countries in South East Asia, more than 80% of ducks are kept in small-scale household farms. An extensive waterfowl production in small scale farms plays a crucial role in rural areas in Asian countries which provide access to natural feed sources such as insects, worm, slug, and golden snail. However, duck performance in this condition is low. Inexpensive feedstuff could compensate the drawback of this low performance. Offering feed according to duck's need and using natural feed additive in the surrounding area may improve duck productivity.

As more commercial duck farming is badly managed, many new diseases occur. Avian influenza virus (HPAI clade 2.3.2) was first detected in 2012. This virus causes high mortality rate (75-100%), especially on young ducks. In addition to virus carriers, duck mort brings a tremendous economic loss to the farmers [11].

The following measurements could support family duck farms to achieve higher productivity as a presupposition for more meat and eggs: (1) Providing of ducklings of improved genotypes from parent-stock farms; (2) Offer of concentrate as additional feed for better utilization of natural feed resources and to ensure balanced nutrition. Free-range ducks can suffer from a shortage of vitamins and minerals; (3) Management has to be improved, especially for protecting ducklings in the first weeks of life by providing an additional heat source as well as drinking water and protein-rich feed; (4) Using of veterinary service, vaccination programs and disease control; (5) Improving education, training and extension by radio programs and demonstration farms [2].

### Acknowledgements

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