Oral Session | Food Quality
[4-1330-D] Food Quality (2)
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[4-1330-D-02] Nutritional Quality of Fertilized and Salted Philippine Mallard Duck (*Anas platyrhynchos L.*) Eggs Consumed in Victoria, Laguna, Philippines

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Keywords: Philippine Mallard Duck, Fertilized Duck Eggs, Salted Duck Eggs, Nutritional Quality

Duck industry is considered as the second largest in the Philippine poultry industry that contributes to farmer’s income through egg and meat production. Ducks are mainly raised for the production of boiled fertilized eggs known locally as *balut* and salted duck eggs.The recent increase in the demand and consumption of these commodities because of diet diversification and utilization, fostered the growth in the duck industry as well as assure sustainable supply of the raw materials for utilization in processing *balut* and salted eggs. To help establish standards for both the quality and safety of *balut* and salted egg, the nutritional property of these two commodities was evaluated in one of the popular towns known to produce *balut* and salted duck eggs. Proximate, mineral and fatty acid analyses of*balut* and salted eggs were done. Both *balut* and salted duck eggs were found to contain considerable amount of protein and calories at 11% and 100%, respectively. In general, the major fatty acids found in duck eggs are oleic acid (C18:1), myristic acid (C14:0) and linolenic acid (C18:2). Salted eggs contained more oleic acid (52.18%) while *balut* has more myristic acid (26.30%). Salted eggs showed higher sodium content as affected by the clay-salt curing process. However, the level of salt still conforms within the recommended nutrient intake for sodium. This study contributes in addressing research gaps in the lack of information for standards and marketing distribution of these products as well as provide information on the nutritional comparison with similar commodities.

Nutritional Quality of Fertilized and Salted Philippine Mallard Duck (*Anas platyrhynchos L.*) Eggs Consumed in Victoria, Laguna, Philippines

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ABSTRACT

Duck industry is considered as the second largest in the Philippine poultry industry that contributes to farmer's income through egg and meat production. Ducks are mainly raised for the production of boiled fertilized eggs known locally as *balut* and salted duck eggs. The recent increase in the demand and consumption of these commodities because of diet diversification and utilization, fostered the growth in the duck industry as well as assure sustainable supply of the raw materials for utilization in processing *balut* and salted eggs. To help establish standards for both the quality and safety of *balut* and salted egg, the nutritional property of these two commodities was evaluated in one of the popular towns known to produce *balut* and salted duck eggs. Proximate, mineral and fatty acid analyses of *balut* and salted eggs were done. Both *balut* and salted duck eggs were found to contain considerable amount of protein and calories at 11% and 100%, respectively. In general, the major fatty acids found in duck eggs are oleic acid (C18:1), myristic acid (C14:0) and linolenic acid (C18:2). Salted eggs contained more oleic acid (52.18%) while *balut* has more myristic acid (26.30%). Salted eggs showed higher sodium content as affected by the clay-salt curing process. However, the level of salt still conforms within the recommended nutrient intake for sodium. This study contributes in addressing research gaps in the lack of information for standards and marketing distribution of these products as well as provide information on the nutritional comparison with similar commodities.

Keywords: Philippine Mallard Ducks, Fertilized Duck Eggs, Salted Eggs, Nutritional Quality

1. INTRODUCTION

Processing and consumption of duck eggs has long been done in Asian countries particularly in China, South Korea, Bangladesh, Thailand, Vietnam, Lao, Malaysia, Singapore and Philippines (Tang et al., 2019; Ahmad et al., 2017; Ganesan et al., 2014; Chang and Dagaas, 2004). Apart from its importance as an integral part of the food culture in these countries, duck eggs were also reported as a good source of protein and other nutrients and is regarded as a food with high nutritional quality (Ahmad et al., 2017; Al-Obaidi and Al-Shadeedi, 2016). People eat duck eggs for its high nutritional value because of the optimal composition of essential amino acids and the considerable composition of fatty acids with a high percentage of polyunsaturated fatty acids and a favorable ratio of omega 6- to omega 3-fatty acids. In addition, it is economical as well as quick and easy to prepare and serve.

In the Philippines, the duck industry contributes to 20.32% of the 55.4 billion peso contribution of the poultry industry in the country's Gross Domestic Product (GDP) (PSA, 2019). The duck egg volume of production reached a total of 46.61 thousand metric tons in 2019 (PSA, 2019). This volume grew by 2.60 percent relative to its previous year's level of 45.43 thousand metric tons (PSA, 2019). In general, about 87% of the total duck egg production is processed into *balut* (fertilized duck egg embryo), 7% to salted eggs and the remaining 6% for other duck egg products like century eggs and *penoy* (Chang & Dagaas, 2004).

In terms of production and processing of duck eggs, the town of Victoria in the province of Laguna was dubbed as the "Duck Raising Center of the Philippines" (Atienza et al., 2015). According to the Department of Agriculture (2003), the duck industry in Victoria is a 5.5 billion peso industry which contributes a total duck egg production of 2.5 billion pesos. The town is known for its duck products which include meat and eggs, particularly *balut* and salted egg.

Balut is produced by incubating fertilized duck egg at 40-42.5°C with high humidity. After 18 days, a partially developed embryo can be seen during candling. These "embryonated eggs" are harvested, boiled and sold as *balut*. *Balut* is known to be good but inexpensive source of protein and calcium (Magat, 2002)

along with other nutrients as stated in the Philippine Composition Table (FNRI, 1997). In practice, the infertile eggs can either be processed to salted egg, century egg or *penoy*.

Salted egg is produced by brining or by curing in clay. In most duck farms in the Philippines, curing in clay is often used. This method involves coating duck eggs with a mixture of clay and salt then stored indoors at room temperature for 18 days. After curing, salted eggs are boiled for 20-30 mins prior to consumption. Some producers cover the egg shell with red food colorings or markings for salted eggs to differentiate them from fresh eggs and other egg products as part of the marketing strategy for this egg product.

Both *balut* and salted duck eggs are consumed based on the fact that eggs, in general, are good sources of protein and fat. It also contains dietary macro-minerals (Ca, P, Na, K, Mg) and trace minerals (Fe, Zn, Cu, Mn) (FNRI, 1997). Duck eggs, as in the case of *balut* and salted eggs, are preferred over hen eggs because of its larger size (about 30% bigger) and higher nutritional value which is attributed to higher fat content found in duck eggs (Ahmad et al., 2017). This is because duck eggs contain relatively less water and higher percentage of proteins and fats in the yolk, albumen and total contents of egg as compared to chicken eggs (Rahman et al., 2010).

Variability in the nutritional composition of eggs are dependent on several factors. More often, it is affected by the kind of nutrients fed to the animal. In the Philippines, the feeds for the ducks are normally supplemented with other agricultural products found within the vicinity or location of the duck farms. Another factor that affects the quality of nutrients in duck eggs is the manner of processing. Processing can alter the nutritional composition of the eggs (Ganesan et al., 2014). Thus, it is important to maintain the nutritional quality of the duck eggs even after processing. The maintenance of the egg quality from the time of their production till their delivery to the final consumer is of great importance (Rahman et al., 2010). Information on nutritional composition of duck specifically from the town of Victoria can be a valuable information especially on the marketing strategy of the community involved in processing of the duck eggs from the duck farms in this area. Apart from its economic value, it is necessary to know the nutritional quality of duck eggs for consumer's satisfaction. In addition, the data that was generated from this study on

the nutritional quality can be a benchmark for other localities engaged in duck production and processing, particularly, *balut* and salted duck eggs in the Philippines as well as other countries in Asia engaged in duck production and processing. Thus, a comparative study on the total nutritional quality and value of fresh, fertilized and salted duck eggs from Victoria, Laguna, Philippines were explored.

2. MATERIALS AND METHODS

2.1 Egg Samples

Convenience sampling was employed in the selection of egg samples from outlet stores in Victoria, Laguna from May to July 2018. *Balut* eggs were immediately boiled for 45 mins. All eggs samples were carefully cracked, shells removed and homogenized in the Osterizer blender prior to analysis. Additional sample preparation were done in accordance with succeeding analyses.

2.2 Determination of Proximate and Nutrient Composition of Duck Eggs

Proximate Analysis. Proximate analysis such as moisture, protein, fat, ash and carbohydrate were determined according to AOAC method (2000). Moisture content was determined by oven drying at 105 $\pm$ 5^0C. Protein content (x 6.25) was determined by Kjeldahl method as stated in AOAC (2000). The fat content was determined by Soxhlet method. Ash was determined by incineration of the dried sample at 600^0C for 5 h (AOAC, 2000). The carbohydrate content was computed as nitrogen free extract (NFE) by subtracting the moisture, protein, fat and ash content**.**

2.3 Mineral Analysis. Egg samples were hydrolyzed by wet ashing (AOAC, 2000) using strong acids: nitric acid (HNO_3), perchloric acid ($HClO_4$) and hydrochloric acid (HCl) prior to mineral analysis. Atomic absorption spectrophotometry was used to quantify the minerals in all samples. All mineral concentrations were reported in parts per million (ppm).

2.4 Fatty Acid Profile of Oils extracted from Duck Eggs. Petroleum ether was used to extract oils from egg samples by shaking for 1 h. The extracted oils were placed in vials for storage in the freezer until analysis. Oil samples were submitted to the Central Analytical Services Laboratory, National Institute

for Molecular Biology and Biotechnology, (BIOTECH-UPLB) for fatty acid profiling against fatty acid methyl ester standards using Gas Chromatograph (AOAC 969.33; 963.22, 2000).

2.5 Statistical Analysis

All of the experiments were performed in triplicates, and the results are expressed as means ± SD. Statistical analyses were performed using the Student's t-test. Differences were considered significant at $P < 0.05$. Means are compared using T-test at $P < 0.05\%$.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Fresh Duck Eggs, *Balut* and Salted Eggs

Nutritional quality is often associated with the amount of basic nutrients found in certain food products. Carbohydrate, fat and protein content in most food are used as indices whether certain food items are important sources of those particular nutrients. In general, eggs are known for its protein, fat and mineral content. However, it also contains other nutrients such as carbohydrate, free amino acids and vitamins.

Proximate composition of duck eggs are shown in Table 1. Ash content in food materials is often use as an index of the mineral content. Previous studies (Ahmad et al. 2017; Zhao et al., 2014; Ganesan et al., 2014) have reported ash content of duck eggs in both fresh and salted eggs. The amount of ash obtained ranged from 1.01-1.87%, these values were comparable to the ash content from duck eggs as reported by Ahmad et al. (2017).

Moisture content of *balut* (65.95 ± 0.06%) was significantly lower compared to fresh duck egg (72.19 ± 0.32%) and salted egg (72.74 ± 0.83). Moisture loss in *balut* can be attributed to the longer processing time (45mins) compared to salted eggs (25mins). Processing lowers the moisture content of duck eggs, a phenomenon, also observed in other food and agricultural products. Further, prolonged heat treatment causes slight shrinking of the contents of eggs. *Balut* is also found to contain higher amount of fiber (4.33 ± 0.28%) due to the partially developed feathers of the embryo. The presence of the

underdeveloped duck embryo is characteristic to fertile duck eggs incubated for about 16-18 days or even 20 days in other countries.

Processing alters the protein composition. This was observed in the amount of protein before and after processing of the duck eggs. In this study, duck eggs were found to be an extensive source of protein but the protein content of both *balut* and salted eggs used in this study decreased during processing. The values obtained ranged from 11.49 to 15.54 %, the latter was exhibited by the fresh duck eggs. These values were comparable to that reported by Dirwan-Muchlis and Nurcholis (2019). At the cellular level, high temperature increases the kinetic energy of protein molecules that leads to their denaturation and later to the formation of stronger covalent bonds with other protein molecules. The previously attached water molecules to the proteins are now released resulting in moisture loss and hardened egg contents. From 15.54 % ± 3.73 proteins in fresh eggs, only 11.89 ± 1.28% and 11.49 ± 2.29% for *balut* and salted eggs, respectively, were retained after processing. During protein degradation, proteins are broken down to their primary structures in the form of amino acids. Some amino acids form volatile compounds under alkali conditions which might have also transferred to the curing solution (Zhao et al., 2014), as in the case of salted eggs.

On the other hand, higher amounts of lipids are observed in salted eggs (10.15 ± 0.11%). Lipids in eggs exist as low-density lipoproteins (LDL) in the yolk plasma (Gilbert, 1971). During clay-curing, sodium chloride (NaCl) leads to dehydration and destruction of LDL structures. Some of the lipids of the cooked yolk become free (Lai et al., 1997) and contributed to the total fat obtained as shown in Table 1.

However, contrary to the results presented by Wang et al. (2014) that the fat content in eggs can be reduced to 0.61% by salting, this study showed that the fat content of the salted duck eggs had a significant increase in fat content compared to fresh duck egg and *balut*.

Table 1. Proximate composition of fresh, *balut,* and salted duck eggs.

Composition*, %	Fresh Egg	*Balut*	Salted Egg
Moisture	72.19 ± 0.32[a]	65.95 ±0.06[b]	72.74 ± 0.83[a]
Fat	4.49 ± 0.47[b]	4.01 ± 0.19[b]	10.15 ± 0.11[a]
Crude Fiber	2.42 ± 0.19	4.33 ± 0.28[a]	1.07 ± 1.11
Protein	15.54 ± 3.73[a]	11.89 ± 1.28[b]	11.49 ± 2.29[b]
Ash	1.28 ± 0.13	1.63 ± 0.42	1.01 ± 0.13

*Means with the same superscript are not significantly different from each other at P <0.05.

3.2 Mineral Composition of *Balut* and Salted Eggs

Table 2 shows the amount of trace minerals of fresh, *balut* or salted egg. Results indicated that processing into *balut* and salted egg does not significantly affect the amount of minerals found in duck eggs. In particular, magnesium (Mg), zinc (Zn), copper (Cu) and manganese (Mn), ranged from 0.16-0.24mg/100g, 0.04-0.06mg/100g, 0.01-0.11mg/100g and 2-4µg/100g, respectively. Results, further exhibited that iron (Fe), was present at higher concentration in *balut* (0.51mg/100g) compared to fresh duck and salted eggs. The iron content however, is lower than the amount reported by Ganesan et al. (2014). Potassium is mostly lost during cooking, as manifested by its low concentration in *balut* (1.85mg/100g). In the case of salted eggs, curing played an important role in the concentration of inorganic minerals. Significant amounts of K (4.57mg/100g), Na (13.28mg/100g), and Ca (4.07mg/100g) were observed for salted eggs as shown in Table 2. The clay-salt mixture provided a barrier to minimize mineral losses in duck eggs while allowing minerals from the mixture to penetrate the egg shell and migrate into the eggs. In general, the mineral content of the duck eggs used in this study were ten times lower compared to previous studies reported (Durwan Muchalis and Nuchalis, 2019; Ahmad et al., 2019; Ganesan et al., 2014).

Table 2. Mineral composition of duck eggs.

Minerals (mg/100g)*	Fresh Eggs	*Balut*	Salted Eggs
P	4.44 ± 0.36 [a]	4.92 ± 0.11 [a]	3.76 ± 0.01 [b]
K	3.92 ± 0.02 [b]	1.85 ± 0.02 [c]	4.57 ± 0.01 [a]
Na	5.04 ± 0.01 [b]	1.24 ± 0.05 [c]	13.28 ± 0.02 [a]
Ca	3.61 ± 0.00 [b]	3.47 ± 0.02 [b]	4.07 ± 0.01 [a]
Fe	0.14 ± 0.01 [b]	0.51± 0.02 [a]	0.10 ± 0.01 [b]
Mg	0.29 ± 0.01 [a]	0.16 ± 0.01 [a]	0.24 ± 0.01 [a]
Mn	0.002 ± 0.0006 [a]	-	0.004 [a]
Zn	0.04 [a]	0.06 [a]	0.04 [a]
Cu	0.01 [b]	0.01 [b]	0.11 ± 0.01[a]

*Means with the same superscript are not significantly different from each other at P <0.05.

3.3 Nutritional Value of *Balut* and Salted Eggs

Duck eggs weigh about 65 g on the average and provide 79-91 kcal based from the results presented in Table 3. Protein was found to provide 7-10g/65g or 4-10% of the recommended dietary allowance for adults (FNRI, 1997). This value means that duck eggs are considered as a good source of protein.

Additional recommendation of the Food and Nutrition Research institute (PDRI, 2015) for adult male 19-39 years of age, is to limit the sodium intake to <2 g and increase the intake of potassium to about 3, 510 mg in adult. Table 3 shows that salted eggs exhibited the highest sodium intake per serving which is estimated at 863 mg/65 g. Potassium, on the other hand, was computed at 297 mg/ 65 g of duck eggs. High salt content for salted egg is as expected because of the processing method used to produce these products. In related studies, salt content in salted eggs in general, ranged from 7-10% after curing for 15- 30 days (Wang, 2017).

However, the estimated cholesterol content of salted eggs is 202.00 mg as calculated based from a study conducted by Aziz et al. (2012). The cholesterol content of duck egg with 60 g average weight yolk

proportion is 186.46 mg. In the Nutritional Guidelines for the Prevention of Heart Diseases and Diabetes Mellitus (FNRI-DOST, 2002), it was stated that the dietary cholesterol should be less than 300 mg/day. With the estimated cholesterol content, duck egg already provides 67% of the recommended dietary cholesterol.

Therefore, inclusion of duck eggs, particularly salted eggs, should be done in moderation due to its big contribution to dietary cholesterol and minimal contribution to mineral intake.

Table 3. Composition (per serving size of 65g) of fresh and processed duck eggs.

Components	**Fresh Eggs**	***Balut***	**Salted Eggs**
Total Fat, g	3	3	7
Total Carbohydrates, g	3	8	2
Fiber, g	2	3	0.6
Protein, g	10	8	7
Calories, kcal	80	90	100
Na, mg	3.3	0.8	8.6
K, mg	2.5	1.2	3.0

3.4 Fatty Acid Composition of *Balut* and Salted Eggs

The amount of fatty acids is affected by the nutrients incorporated in the feeds given to ducks. Duck eggs are found to contain more unsaturated fatty acids than saturated ones. The major fatty acids in egg lipids are oleic, myristic and linoleic acids found in duck eggs from Victoria, Laguna, Philippines are shown in Table 4. Salted eggs had the highest amount of oleic acid (51.57%); *balut* has more myristic acid (26.30%). Linoleic acid is found to decrease after processing from 12.52% in fresh eggs to 10% in processed eggs (10.34% in *balut* and 10.04% in salted eggs). This is in contrast to that reported by Men et al. (2015)

wherein palmitoleic acid and linoleic acid took a greater proportion in the unsaturated free fatty acids, and their contents increased during the pickling period of salted duck eggs.

Myristic and lauric acid are strongly correlated with higher cholesterol levels (German & Dillard, 2010). Combined myristic and lauric acid for duck eggs range from 27.28 – 29.34%. This should be considered in the consumption and inclusion of duck eggs in the diet.

Table 4. Fatty acids in duck eggs as compared to coconut oil.

Fatty acid (% distribution)	**Fresh Egg**	**Salted egg**	***Balut***
C10:0	0.58	0.46	0.69
C12:0	2.29	4.24	1.58
C14:0	26.27	25.10	26.20
C16:0	2.15	1.31	0.59
C18:0	2.88	ND	3.62
C18:1	46.93	52.18	51.57
C18:2	12.52	10.34	10.04

4. CONCLUSION

Processing into salted eggs and *balut* has significantly affected the nutritional value of fresh duck eggs, including but not limited to their proximate composition and nutritional contents. Proteins, compared to other macronutrients, underwent the most biochemical and structural changes during processing. *Balut* and salted eggs provide more energy than fresh duck eggs based on the results of this study. Curing of eggs in clay-salt does not increase sodium levels in the salted eggs that could pose a health issues, however, consumption of these eggs must be done in moderation since they contain high levels of cholesterol.

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