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FULL PAPER

Physicochemical, nutritional and sensory qualities of salted Philippine mallard duck (*Anas platyrhynchos* L.) eggs

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Abstract

Diet diversification as well as a sustainable supply of the raw materials for utilization in processing salted eggs leads to an increase in the demand and consumption of salted duck eggs in the Philippines. In this study, the physicochemical, nutritional and sensory properties of salted duck eggs made in the laboratory were evaluated. Physicochemical properties revealed that the sample collected registered a pH and water activity of 7.1 and 0.88, respectively. In addition, the samples showed a total colour difference of 15.01 using the Hunter scale system. The samples exhibited an average of 1.03% salt content. Furthermore, proximate composition, mineral and fatty acid analyses of samples proved that a considerable amount of these nutrients were present in salted duck eggs that were analysed. Protein, fat, carbohydrate, crude fibre and ash content were 11.49, 10.15, 3.54, 1.07 and 1.01%, respectively. On the other hand, minerals such as phosphorus, potassium and calcium were recorded at 4.46, 3.92 and 3.61 mg/100 g, respectively. In general, the major fatty acids found in the samples were oleic acid (C18:1), myristic acid (C14:0) and linolenic acid (C18:2). Sensory evaluation revealed that flavour was regarded by the panellist as a major consideration in evaluating the quality of salted duck eggs. This study proved that salted duck eggs have nutritional and quality characteristics that can be considered as an alternative source of protein, fat and minerals for human consumption.

1. Introduction

Processing and consumption of duck eggs have long been done in Asian countries particularly in China, South Korea, Bangladesh, Thailand, Vietnam, Lao, Malaysia, Singapore and the Philippines (Dagaas and Chang, 2004; Ganesan *et al*., 2014; Ahmad *et al*., 2017; Tang *et al*., 2019). Recently, there was an annual increase in the production of duck meat and eggs globally (Fouad *et al*., 2018). 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 are regarded as a food with high nutritional quality (Al-Obaidi and Al-Shadeedi, 2016; Ahmad *et al*., 2017). People eat duck eggs for their 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 favourable ratio of omega 6- to omega 3-fatty acids (Al -Obaidi and Al-Shadeedi, 2016). 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). Duck raising in the Philippines largely focused on egg production (Chang *et al*., 2005). 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* (Dagaas and Chang, 2004).

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, of which 2.5 billion pesos is contributed by duck egg production. The town is known for its duck products which include meat and salted duck egg.

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Since livestock products like duck eggs have perishable properties, preservation techniques are applied to maintain egg quality. Salting duck eggs are commonly employed to preserve the raw eggs as well as improve their texture and flavour. Salted eggs are one of the most traditional and popular preserved egg products. Salted eggs are made by brining eggs in saturated saline or by coating eggs with a soil paste mixed with salt for approximately 15-30 days (Chi and Tseng, 1998). Salt is a useful additive to preserve and improve the taste of a product. The yolk solidifies gradually and becomes hard during the brining process, and the egg white loses viscosity and becomes watery (Chi and Tseng, 1998). The rate of salt penetration into the egg white and yolk is governed by the salting method and may change the composition and characteristics of the egg, particularly the yolk. In addition, the salting time plays a role in the formation of a properly prepared salted egg (Kaewmanee *et al*., 2009).

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 at a ratio of 1:1, then stored indoors at room temperature for 18 days. After curing, salted duck eggs are boiled prior to consumption. Some producers cover the eggshell with red food colourings 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.

Generally, duck eggs are used to prepare salted eggs because their characteristics are better than those of chicken eggs (Wang, 2017). Consumers expect more egg yolk than egg white. The desirable characteristics of a salted egg yolk include orange colour, oil exudation, and a gritty texture (Kaewmanee *et al*., 2009).

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 are preferred over hen eggs because of their larger size (about 30% bigger) and higher nutritional value which is attributed to the higher fat content found in duck eggs (Ahmad *et al*., 2017). This is because duck eggs contain relatively less water and a higher percentage of proteins and fats in the yolk, albumen and total contents of the egg as compared to chicken eggs (Rahman *et al*., 2010).

Variability in the nutritional composition of eggs is 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 physicochemical and nutritional quality of the duck eggs even after processing. Egg quality is of great importance and should be maintained from the time of production to delivery, and finally, to the consumer (Rahman *et al*., 2010). Physicochemical, nutritional and sensory properties of salted duck eggs can be valuable information especially with regards to the marketing strategy of the community involved in processing the duck eggs straight from the duck farms. Apart from its economic value, it is necessary to know the physicochemical, nutritional and sensory qualities of salted duck eggs both for consumer’s satisfaction and food quality standpoint. In addition, the data that was generated from this study on the physicochemical, nutritional and sensory qualities will serve as the benchmark for other localities engaged in duck production and processing, particularly, salted duck eggs in the Philippines as well as other countries in Asia engaged in duck production and processing. Thus, the physicochemical, nutritional and sensory qualities of fresh and salted duck eggs from Victoria, Laguna, Philippines were explored.

2. Materials and methods

2.1 Egg samples

Duck egg samples were taken from a farm in Victoria, Laguna, Philippines. Samples were collected 4 hrs after oviposition and salt-cured for 18 days. Samples were boiled for 30-45 mins after curing and were homogenized and stored in the freezer prior to analyses.

2.2 Physicochemical analysis

The acidity or the alkalinity of the salted egg samples were tested using a Milwakee pH meter. Approximately 5 g of the homogenized egg samples were diluted with 10 mL distilled water. The pH of the eggs was determined by dipping the pen in the mixture (AOAC, 1998). Water activity, on the other hand, was determined by weighing about 10 g of the salted egg samples then placed inside the Novasina water activity meter. Colour analysis was done using a calibrated Minolta Chromameter following Hunter L, a, b, colour system. The salt content was determined according to the method of Venkatachalam (2018) with slight modifications.

2.3 Determination of the proximate and nutrient composition of duck eggs

Proximate analyses such as moisture, protein, fat, ash, crude fibre and carbohydrate were determined according to the AOAC method (2000). Moisture content was determined by oven drying at 105±5°C. Protein content was determined by the Kjeldahl method as stated in AOAC (2000). The fat content was determined by the Soxhlet method. Ash was determined by incineration of the dried sample at 600°C for 5 hrs (AOAC, 2000). The crude fibre was determined using standard procedure (AOAC, 2000). The carbohydrate content was computed as nitrogen-free extract (NFE) by subtracting the moisture, protein, fat, crude fibre and ash content.

2.4 Mineral analysis

Egg samples were hydrolysed by wet ashing (AOAC, 2000) using nitric acid (HNO_3), perchloric acid ($HClO_4$) and hydrochloric acid (HCl) prior to mineral analyses which includes: phosphorus (P), potassium (K), sodium (Na), calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), zinc (Zn) and copper (Cu). Atomic absorption spectrophotometry was used to quantify the minerals in all samples. All mineral concentrations were reported in parts per million (ppm).

2.5 Fatty acid profile of oils extracted from duck eggs

Petroleum ether was used to extract oils from egg samples by shaking for 1 hr. 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).

2.6 Sensory evaluation of salted duck eggs

A fifteen-point scale for quality scoring was used for the sensory evaluation of the salted eggs. A total of 15 panellists were asked to evaluate the salted egg samples. The cooked eggs were cut along their longitudinal axis to produce two symmetrical parts, and the sections were placed in a dish with their yolks shown. The sensory panel consisted of undergraduate students who had taken a sensory evaluation course; they were asked to describe the samples by assigning a score based on a 15- point scale, where 1 indicates the least and 15 indicates the greatest for most parameters as follows: Egg white colour: 0, white to 15, chalk white; Egg white texture:0, very soft to 15, very firm; Egg yolk colon: 0 yellow to 15, red orange, Presence of oil: 0 none to 15 profuse, Egg white saltiness: 0, not salty to 15 extremely salty; Grittiness of the egg yolk, 0, smooth to 15 very gritty; Flavour, 0, no salted egg flavour to 15 very evident salted egg flavour; General Acceptability, 0 extremely dislike to 15 extremely like. The scores should be given soon after the eggs were cut. Each member of the panel evaluated three randomly selected eggs in a sample set, and mean scores were obtained from the score given by 15 members of the panel.

2.7 Statistical analysis

All of the experiments were performed in triplicates, and the results are expressed as means ± SD. Significant differences between samples were measured by T-test and LSD multiple comparisons at $p<0.05$.

3. Results and discussion

3.1 Physicochemical properties of salted duck eggs

Table 1 shows the physicochemical properties of the salted duck eggs. This study focused on the following physical properties: eggshell hardness, pH, water activity, and colour. On the other hand, samples exhibited a salt content of 1.04%. The result obtained from this study is lower compared to that obtained by Xu *et al*. (2017) which ranged from 2.25 to 11.61% salt. This can be explained by the length of salting time. In this study, the salting time was 18 days as traditionally practised by salt egg processors in the Philippines while in the study of Xu et al. (2017) the salting time was 35 days. The difference in the salting time is dependent on the processing practices of a particular country with considerations to its physicochemical and sensory properties (Xu *et al*., 2017; Venkatachalam, 2018; Sumekar *et al*., 2020). In this study, compliance to the WHO issuance on the recommended salt content of 5 g per day was of important consideration.

Table 1. Physicochemical properties of salted duck eggs.

Parameters	Salted Duck Eggs
Eggshell hardness	43.04
pH	7.10
Water Activity (A_w)	0.88
Total Colour Difference (ΔE*)	15.01
Salt (%)	1.04

*$\Delta E^* = \sqrt{}(L^* - L^*_{ref})^2 + (a^* - {}^{a^*ref})^2 + (b^* - b^*_{ref})^2$

The eggshell may be regarded as inedible but they play an important role in protecting the edible portion of the egg (Fernandes and Litz, 2017). It encloses the internal contents, serves as a barrier for protection against microbial agents, protects the embryo of the egg, and allows gas and water exchange between the external and internal environment. The eggshell hardness is important because it serves to retain the content of the eggs starting from laying, processing and then transport to market. Those eggs that are considered high-quality eggs are the ones with no cracks or any defects in the eggshell. Eggs with cracks can increase the risk of microbial contamination and faster deterioration of the egg. Eggshell hardness is often correlated to the calcium carbonate content of the eggshell. Eggshell is composed of 98% calcium carbonate (Ajayan *et al*., 2020). This study is the first to report the physical analysis using Universal Testing Machine as a parameter for eggshell hardness.

The results of pH and water activity (Aw) as shown in Table 1 are 7.1 and 0.88, respectively. These values were comparable to that reported by Wongvilairat (2007), wherein commercially available salted eggs exhibited a pH of 6.7±0.09 and water activity (Aw) of 0.921±0.04, However, with these values, both results categorized salted eggs as high moisture and neutral pH product. In general, salting reduces the water activity of food products. On the other hand, the pH value can be attributed to processing factors such as salt concentration, salting time, and boiling time after curing (Benjakul and Kaewmanee, 2017; Xu *et al*., 2017; Zou *et al*., 2018). The pH values of salted eggs are affected by salting time due to the destruction of lysozyme, a basic protein in egg white (Xu *et al*., 2017). Further, reduction of egg moisture content, enhancement of release of carbonic acid gas, and increase in lipid content in egg yolk also influenced changes in pH. Eggs salted with higher concentrations of salt compared to eggs salted with lower concentrations have higher pH values, and this might be attributed to the ovomucin level of the egg white (Xu *et al*., 2017).

Colour is one of the many factors that consumers are taking into consideration when purchasing a product. In salted eggs, the colour of the egg yolk is the most important because some people prefer an orange-red coloured egg yolk and eggs with deeper yolk colour can be sold at higher prices (Nys *et al*., 2011). Colour values of L* a* b* offer objective evaluation of the colour of the eggs, L* indicates lightness, a* is the red/green coordinate, and b* is the yellow/blue coordinate. The L*, a*, and b* values were used to compute for the total colour difference, ΔE* which measures the colour change as a result of treatment from a reference colour (colour values of eggs at 0 storage time was used as reference). In this study, there was an intense change in the colour after salting. As a consequence, there was a remarkable difference in the change of colour. This signifies that salting has an effect on the development of the colour of the yolk. In the Philippines, the intense yellow to the orange colour of the yolk connotes more palatable salted duck eggs. Further, it is also affected by the amount of pigments present in the egg yolk (Caner, 2005). As duck eggs are cured in salt, the moisture content decreases, consequently, the egg yolk colour darkens or intensifies because the pigment concentration is enhanced (Wang, 2014).

3.2 Proximate composition of salted duck 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 is used as indices of whether certain food items are important sources of those particular nutrients. In general, eggs are known for their protein, fat and mineral content. However, it also contains other nutrients such as carbohydrates, free amino acids and vitamins.

The proximate composition of salted duck eggs is shown in Table 2. Ash content in food materials is often used as an index of mineral content. Previous studies (Zhao *et al*., 2014; Ganesan *et al*., 2014; Ahmad *et al*. 2017) have reported ash content of duck eggs in salted eggs. The amount of ash obtained was 1.01%. This value was comparable to the ash content from salted duck eggs as reported by Ahmad *et al*. (2017).

The moisture content of salted duck eggs registered at 72.74%±0.83. This moisture content was comparable to the moisture content obtained by Xu *et al*. (2017) at 76.53% to 84.88%. Moisture content often indicates product stability. In the case of salted duck eggs, it is

The protein composition (11.49%) of the duck eggs after salt curing is shown in Table 2. This value conformed to that reported by Muchlis and Nurcholis (2019) but is 3% lower compared to that obtained by Ganesan *et al*. (2014). 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. During protein degradation,

Table 2. Proximate composition of fresh and salted duck eggs.

Composition	g/100 g		Commercial Salted Duck Egg	Ganesan *et al.* (2014)	
	Fresh Eggs	Salted Egg		Fresh Egg	Salted eggs
Moisture	72.19±0.32	72.74±0.83	73.87±4.84	-	-
Fat	4.49±0.0	10.15±0.11	7.23 ±3.32	11.40-13.52	16.6
Crude Fiber	2.42±0.19	1.07±1.11	1.47 ±0.44	-	-
Protein	15.54±3.73	11.49±2.29	13.91±0.28	9.30-11.80	14.0
Ash	1.28±0.13	1.01 ±0.13	4.15 ±0.34	1.10-1.17	7.5

Values are presented as means±SD, n = 3.

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 were observed in salted eggs by at least two-fold (10.15±0.11%) compared to fresh duck egg samples as shown in Table 2. Lipids in eggs exist as low-density lipoproteins (LDL) in the yolk plasma (Gilbert, 1971). During salting, moisture leaves the egg while salt permeates into the egg white and yolk. Oil exudation in yolk increases with time resulting from dehydration and protein denaturation. The oil exuded from salted egg yolk exists in the form of free lipids, which are released from lipoprotein. Further, sodium chloride (NaCl) leads to dehydration and the destruction of LDL structures. Some of the lipids of the cooked yolk become free (Lai *et al*., 1997) and contribute to the total fat obtained as shown in Table 2. However, this is 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 significantly increased after salt curing. Analysis of ash and crude fibre were at 1.01% and 1.07%, respectively. These values were lower than that obtained by Ganesan *et al*. (2014) and Kaewananee *et al*. (2009) at 2.35% and 6.90% ash, respectively. The lower ash content in this study can be explained by the salting method as well as the amount of minerals or salt present in the soil used for curing the duck eggs. On the other hand, no crude fibre was detected in egg albumen in the study of Chaiyasit *et al*. (2018).

3.3 Mineral composition of salted duck eggs

Table 3 shows the amount of trace minerals of fresh and salted duck eggs. Results indicated that processing into salted duck eggs did not significantly affect the amount of minerals found in duck eggs. In particular, magnesium (Mg), zinc (Zn), copper (Cu) and manganese (Mn), ranged from 0.16-0.24 mg/100 g, 0.04-0.06 mg/100g, 0.01-0.11 mg/100 g and 2-4 µg/100 g, respectively. Further, results exhibited that iron (Fe) content was not significantly different for fresh and salted duck eggs at 0.14 and 0.10 mg/100 g, respectively. The iron content, however, is lower than the amount reported by Ganesan *et al*. (2014). Significant amounts of potassium (K) (4.57mg/100g), sodium (Na) (13.28mg/100g), and calcium (Ca) (4.07mg/100g) were observed for salted eggs as shown in Table 3. The clay-salt mixture provided a barrier to minimize mineral losses in duck eggs while allowing minerals from the mixture to penetrate the eggshell and migrate into the eggs. In general, the mineral content of the duck eggs used in this study was ten times lower compared to previous studies reported (Ganesan *et al*., 2014; Muchlis and Nuchalis, 2019; Ahmad *et al*., 2019). Discrepancies might be attributed to the kind of soil used during the salt curing process as well as the nature of the feed during the egg production.

3.4 Nutritional value of salted duck eggs

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

Additional recommendation of the Food and Nutrition Research Institute (PNRI, 2015) for adult males 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 adults. Table 4 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. The high salt content for a salted egg is as expected because of the processing method used to produce these products. In

Table 3. Mineral composition of fresh and salted duck eggs.

Minerals	mg/100 g		Ganesan *et al.* (2014)	
	Fresh Eggs	Salted Eggs	Fresh Eggs Yolk	Salted Eggs
Phosphorus, P	4.44±0.36[a]	3.76±0.01[a]	-	-
Potassium, K	3.92±0.02[a]	4.57±0.01[a]	131.42	116.74
Sodium, Na	5.04±0.01[a]	13.28±0.02[b]	72.3	3780
Calcium, Ca	3.61±0.00[a]	4.07±0.01[a]	158.22	114
Iron, Fe	0.14±0.01[a]	0.10±0.01[a]	8.51	3.75
Magnesium, Mg	0.29±0.01[a]	0.24±0.01[a]	18.23	10
Manganese, Mn	0.002±0.0006[a]	0.004±0.00[a]	-	-
Zinc, Zn	0.04±0.00[a]	0.04±0.00[a]	3.95	2.83
Copper, Cu	0.01±0.00[a]	0.11±0.00[a]	0.14	0.1

Values are presented as means±SD, n=3. Values with the same superscript are not significantly different at P<0.05.

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related studies, salt content in salted eggs, in general, ranged from 7-10% after curing for 15- 30 days (Wang, 2017).

Table 4. Nutritional composition of fresh and salted duck eggs.

Components	per 65 g serving size	
	Fresh Eggs	Salted Eggs
Total Fat, g	3[a]	7[b]
Total Carbohydrates, g	3[a]	2[a]
Fiber, g	2[a]	0.6[b]
Protein, g	10[a]	7[b]
Calories, kcal	80[a]	100[b]
Na, mg	3.3[a]	8.6[b]
K, mg	2.5[a]	3.0[a]

Means with the same superscript within the row are not significantly different at $P<0.05$.

However, the estimated cholesterol content of salted eggs is 202.00 mg as calculated based on a study conducted by Aziz *et al*. (2012). The cholesterol content of duck eggs 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, the inclusion of duck eggs, particularly salted eggs, should be done in moderation due to their big contribution to dietary cholesterol and minimal contribution to mineral intake.

3.5 Fatty acid composition of salted duck eggs

Duck eggs are found to contain more unsaturated fatty acids than saturated ones. In general, the duck eggs from Victoria, Laguna, Philippines contain major fatty acids such as oleic, myristic and linoleic acids as shown in Table 5. The values obtained in this study conformed to that of Ganesan *et al*. (2014). On the contrary, oleic, palmitic and linoleic acids are the most abundant fatty acids found in salted duck egg yolk according to Kaewmanee *et al*. (2009). Salted duck eggs showed 51.57% oleic acid. On the other hand, linoleic acid is found to decrease after processing from 12.52% in fresh eggs to 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. In addition, Kaewmanee *et al*. (2009) reported that the fatty acid profile of salted duck egg lipid was similar to that of fresh yolk lipid and salting generally had no impact on the fatty acid composition of yolk lipids. On the nutritive fact of the lipids in salted duck egg, they will serve as an alternative low cholesterol egg product, which is also rich in other essential food lipids (Ganesan *et al*., 2014). In contrast, myristic and lauric acid are strongly correlated with higher cholesterol levels (German and Dillard, 2010). Combined myristic and lauric acid for duck eggs range from 27.28 – 29.34% as exhibited in Table 5.

3.6 Sensory characteristics of salted duck eggs

Overall, the flavour of the salted egg samples exhibited the highest score in terms of all the sensory parameters as shown in Table 6. Other sensory parameters tested were egg white colour, egg white saltiness, egg white texture, egg yolk colour, presence of oil, the grittiness of egg white and flavour. The saltiness of the egg white conforms with the high sodium content obtained from the mineral analysis having the second-highest score in terms of sensory evaluation. The egg whites possess neither attractive taste nor special aroma, and they are considerably salty because they contain at least 7–10% sodium chloride (NaCl) (Wang, 2014). Salted egg whites are thus difficult to eat directly; for this reason, large amounts of salted egg whites are discarded yearly.

Further, the sensory evaluation showed that egg white texture and egg yolk colour was significantly different. Consumers love salted eggs mainly for their yolk. Salted egg yolk is considered more delicious and

Table 5. Fatty acids composition of fresh and salted duck eggs.

Fatty acid	Percentage of Total Fatty Acid			
	Fresh Eggs	Salted Eggs	Fresh Eggs*	Salted Eggs (14 d)*
Capric Acid, C10:0	0.58[a]	0.46[a]	-	-
Lauric Acid, C12:0	2.29[a]	4.24[b]	-	-
Myristic Acid, C14:0	26.27[a]	25.10[a]	0.5	0.5
Palmitic Acid, C16:0	2.15[a]	1.31[b]	27.2	27.5
Stearic Acid, C18:0	2.88	ND	6.19	5.63
Oleic Acid, C18:1	46.93[a]	52.18[b]	47.5	48.4
Linoleic Acid, C18:2	12.52[a]	10.34[b]	8.08	6.88

*Kaewananee *et al.* (2009). Values are presented as means±SD, n=3. Values with the same superscript are not significantly different at $P<0.05$.

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nutritious compared to the other parts of salted egg because of its soft and gritty characteristics, aroma, attractiveness, colour, and richness in nutrients, including fat, protein, lecithin, carotenoids, vitamins, and minerals. A desirable salted egg yolk possesses a gritty texture, attractive colour (orange to red), and apparent oil (Wang, 2017). The presence of oil, however, received a low sensory score of 5.14 as shown in Table 6. This is contrary to that obtained by the grittiness of the salted egg yolk which obtained a 2-fold higher score on the scale at 7.86. It should be noted, however, that the free lipids on the interface of granulated yolk spheres (oil) provide the gritty texture of cooked salted egg yolk (Muchlis and Nurchalis, 2019).

Table 6. Mean scores of sensory properties of salted duck eggs made in the laboratory compared to commercially available samples.

Sensory Properties	Values Salted duck Eggs Samples	Commercial Samples
Egg white colour	5.73^a	5.59^a
Egg white texture	7.04^a	8.25^a
Egg yolk colour	6.97^a	8.33^b
Presence of oil	5.14^a	7.9^b
Egg white saltiness	7.57^a	8.45^a
Grittiness of egg yolk	7.86^a	8.68^b
Flavour	8.16^a	10.95^b
General acceptability	6.17^a	10.1^b

Means with the same superscript within the row are not significantly different at P<0.05 based on LSD test at 95% level of significance.

On the other hand, egg white texture can be influenced by several factors, namely protein content, heating temperature, ion strength and the interaction with other components (Muchlis and Nurcholis, 2019). These factors also contribute to the salted egg flavour which obtained the highest consideration in terms of sensory evaluation as shown in Table 6.

4. Conclusion

Duck eggs collected from the town of Victoria, Laguna in the Philippines was salted and cured in the laboratory. According to the results, it can be concluded that the salted duck eggs samples contain a variety of nutrients such as protein, fatty acids, and minerals. There was also no significant difference in the amount of nutrients present in both the fresh and the salted egg samples. Sensory evaluation conformed to the results of the physicochemical and nutritional studies. In general, this study proved that the traditional practices in salted egg production as well as the agricultural practices in the town of Victoria, Laguna, Philippines conformed to other studies and thus, can be used as a source of information for the development of standards for salted eggs in the Philippines. However, the development of other technologies to improve the production process is still recommended.

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