

# Food Safety Study of Duck Eggs Produced Along Laguna Lake Areas, Philippines

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## Abstract

This study aimed to determine the farm practices related to duck egg production as well as assess the safety of duck eggs for human consumption. Specifically, it aimed to 1) describe farm practices related to duck egg production in the Province of Laguna.; 2) determine the volume of egg production and its geographic flow; and 3) assess the safety of the duck eggs for human consumption in terms of its lead (Pb) content by comparing it with the maximum tolerable daily intake of Pb set by the World Health Organization (WHO). Results showed that the number of ducks raised ranged from 800 to 45,000 heads. Each farm had their own way of feeding ducks except for the use of snails as feeds that is common to all. In addition to snails, a mixture of commercial feeds, desiccated coconut (sapal) and fine rice particles (binlid) were given as feeds. The lead concentrations of raw duck eggs from the three farms were 0.20 mg/kg Fresh Weight (FW), 0.22 mg/kg FW and 0.20 mg/kg FW for samples A (Los Baños), B (Bay) and C (Victoria), respectively with a mean Pb content of 0.21 mg/kg FW. Also, the mean Pb content of duck eggs analyzed is far higher than the mean Pb content of eggs in developed countries (0.02 mg/kg) as well as with the Pb content of water spinach that were grown near the domestic areas alongside Laguna de Bay (0.02 mg/kg FW). Furthermore, it is found to be within the recommended maximum concentration of Pb in solid food, that is, 6 mg/kg. Using the maximum tolerable daily intake of Pb for adult set by the WHO (2001) which is 0.21 mg/kgBW as reference, developing Pb toxicity from the intake of duck eggs over a short period of time is therefore impossible. Nonetheless, heavy metals like Pb can accumulate in the body when consumed over a long period of time and pose health hazards. As a conclusion, the presence of Pb in duck egg may cause health hazards when taken in excess amounts over a long period of time. Further studies on safety of duck egg for human consumption as well as health risk assessment are recommended as basis for development of policies related to human health and environment.

**Keywords:** Environmental health; Food safety; Duck farming practices

## Introduction

Duck raising is one of the profitable livestock industries in the Philippines. Because of its eggs such as *balut* and salted eggs with its nutritive value, delicious flavor and affordable price makes it one of the delicacies for Filipinos. Most of these duck raising industries are along the shoreline of Laguna de Bay because of the abundant fresh water supply and fresh water snails that serve as food for the ducks.

Historically, the town of Pateros has been identified in centuries in the *balut* industry but due to the proliferation of commercial and industrial establishment and its urbanization leading to an increase in population it has lost its touch and identity. Presently, the salted eggs and *balut* industry may be found in the province of Laguna. Most of these are in the municipalities that lie along the coastline of Laguna de Bay.

The town of Victoria is the largest duck raising farm in the province of Laguna and probably in the whole Philippines. It became the destination of traders and became known as the “Duck Raising Center of the Philippines”. It manages and raises a total of more or less 55,000 mallard ducks that hatch the same number of eggs. According to statistics from the Department of Agriculture (2003), the Php 5.5 billion duck industry comes from the municipality of Victoria. In the year 2003, the country produced fifty-four (54) million kilograms of duck eggs and likewise the same volume of duck meat. And the total

duck egg production amounted to Php 2.5 billion with the combined duck meat output grossed in the amount of Php2.93 billion. The eggs are transported to Metro Manila and nearby provinces where they are cooked to the tasty *balut* or processed to become boiled eggs or *penoy*, and salted eggs or *itlognapula* [1].

Laguna Lake serves several purposes such as source of potable water supply, irrigation for agriculture, water source for industrial cooling, power generation, transport route, floodwater reservoir as well as location for tourism and recreation. One of the major roles of the lake is a ground for aquaculture. It is a source of fish, molluscs and crustaceans and serves as biological source not only of food but of feeds, like the snails for other animals [2]. The current conditions of Laguna Lake have become essential with its primary role as a resource

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for food. The diverse existence of species in the lake leads to several livelihood activities as well for the population surrounding the lake and one of these is duck raising.

With the presence of abundant snails in Laguna Lake, duck raising then becomes a good option in the towns surrounding it as source of livelihood. In fact, several municipalities in Laguna are known for duck raising and producer of salted eggs and *balut* (boiled incubated duck's egg). Since the lake plays a major role in this kind of livelihood, conditions of the lake may then affect the products dependent on the lake especially the food industry that may further affect the human conditions particularly on health.

Food safety is a key concern of environmental health. A food is safe when it is free from infectious agents or toxic substances that can harm human health [4]. The safety of food plays a major role not just in the promotion of human health but in the attainment of food security as well. Its strong link to food security is highly evident in the 1996 World Food Summit food security definition, that is, "food security is when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" [5].

Food contamination can happen in any points of the food chain; hence, food safety must be a shared responsibility of the people involved in food production, food processing and transportation, marketing as well as at the consumers' level. The World Health Organization (WHO) has adopted a "farm-to-fork" approach in order to identify and focus efforts on those points of the food production chain where contamination of food is most likely to occur or most likely to be prevented [6].

Food production is a complex process, with food safety as one of the ultimate objectives. However, food that is generally expected to be safe may become unsafe due to the introduction of hazards during production, processing, storage, transport, or final preparation for consumption. For food derived from animals like eggs, the hazard may originate from a number of sources including the consumption by food production animals of contaminated feed.

Heavy metals including mercury, lead, or cadmium are some of the hazardous substances in feeds. These toxic metals can accumulate in animal tissues or are excreted in milk or become incorporated in eggs at levels in excess of established limits or maximum levels for contaminants in a food or feed [7,8].

In the Philippines, duck egg production is one of the major sources of livelihood of Filipino Families. Duck egg is a typical food for Filipinos. It is customarily eaten as a main dish like salted egg, as a snack food such as "balut" and "penoy" and as ingredient in Filipino cookery such as "puto-pao" and bibingka. According to the Bureau of Agricultural statistics (Bureau Agricultural Statistic), it is the second most widely consumed in the Filipino diet with mean per capita intake of almost one-half kg per year. According to the Food and Nutrition Institute of the Department of Science and Technology [9], duck egg is not just a plain nutrient source but a functional food as it has components such as lutein and zeaxanthin that reduce the risk of cataracts and macular degeneration. As a nutrient source, duck egg is the richest source among all varieties of eggs (Table 1); and therefore provides the highest percent of the Recommended Dietary Allowance (% RDA) (Table 2).

Duck egg production sites are normally located near the rivers and lakes. In Laguna, large-scale duck egg producers are located in Municipalities of Los Banos, Bay and Victoria. All municipalities are situated in areas bordering Laguna de Bay. Traditionally, lakes and rivers serve as the sources of aquatic foods for the ducks such as snails and shells. These aquatic foods are recognized as better feeds as they help form richer egg yolk and thicker egg shell that add premium to egg products [10].

Rapid industrialization, urbanization, population growth, and increasing resource utilization account for the pollution of this lake. One of the most common water pollutants is the heavy metals such as lead (Pb) and cadmium (Cd) that are non-essential and toxic in low concentrations. These heavy metals can be absorbed by aquatic plants and animals [11]. Animals and humans that ingest these aquatic resources can in turn obtain these heavy metals.

In terms of safety, a slight increase from the maximum tolerable intake by man set by the World Health Organization can have dangerous effects on human health. Pb toxicity includes negative impacts on the central nervous system, kidneys, and bones [12,13].

Foods must be safe for consumption at all times. The accumulation of heavy metals in food poses a threat in the health of the Filipinos. Since duck egg, which is one of the cheapest commodity and staple food that make up the normal Filipino diet, are produced by duck that is grown at the lakeside of Laguna de Bay, there is a need to monitor the concentrations of the heavy metals in this food. This study aimed to assess the Pb concentrations in duck eggs from production sites

Type of Egg	Energy (kcal)	Protein (g)	Fat (g)	CHO (g)	Ca (mg)	P (mg)	Fe (mg)	Vit.A (ug)	Thia-min (mg)	Ribo-flavin (mg)	Nia-cin (mg)	Vit.C (mg)
Chicken Egg (1 pc = 48 g)	77	5.9	5.3	1.3	36	86	1.3	145	0.03	0.19	2.3	0
Duck Egg (1 pc = 54 g)	96	6.3	6.8	2.2	38	94	1.5	267	0.15	0.3	1.2	Tr
Quail Egg (1 pc = 8 g)	12	0.9	0.8	0.2	6	18	0.2	26	0.01	0.03	0.01	0
Quail Egg (6 pcs = 48 g)	73	5.7	5.1	1.3	38	107	1	158	0.07	0.16	0.05	0

Table 1: Nutritional value of eggs.

Type of Egg	Energy (kcal)	Protein (g)	Ca (mg)	Fe (mg)	Vit.A (ug)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)
Chicken Egg (1 pc = 48 g)	2.9	9.8	7.2	10.8	27.6	2.3	14.6	9.2
Duck Egg (1 pc = 54 g)	3.7	10.5	7.6	12.5	50.9	11.5	23.1	4.8
Quail Egg (1 pc = 8 g)	0.5	1.5	1.2	1.7	4.9	0.8	2.3	0.6
*Quail Egg (6 pcs = 48 g)	2.8	9.5	7.6	8.3	30.1	5.4	12.3	0.2

Table 2: % RDA contribution of different types of eggs for a reference man, 20-39 years old.

located near Laguna Lake. This study hoped to provide data for future investigations.

## Objectives

Generally, the study aimed to describe the farm practices related to duck egg production as well as determine the safety of duck eggs for human consumption. The following are the specific objectives of the study:

- Describe farm practices related to duck egg production in the Province of Laguna;
- Determine the volume of egg production and its geographic flow; and
- Assess the safety of the duck eggs for human consumption in terms of its Pb content by comparing it with the maximum safe limit set by the World Health Organization (WHO).

## Scope and Limitation

The study was limited to analysis of the Pb content of raw duck eggs from three large-scale production sites at the lakeside towns of Laguna de Bay, Philippines. Other heavy metals such as mercury and cadmium as well as duck egg processed products were not included in the study due to budget constraint. Moreover, factors such as maturity of eggs and season of harvest of eggs that may confound the analysis were not considered in the study due to time constraints.

## Methodology

### Sampling areas

Three large-scale production sites of duck eggs in Laguna Province in the Philippines (Los Baños, Bay and Victoria) were purposively selected in the study. The selection criteria were proximity to the lake and volume of egg production. The following are the detailed description of sampling areas.

**Los Baños:** The municipality of Los Baños is known as the Nature and Science City. It is a first class urban municipality in the province of Laguna. It has a population of 101,884 with a total land area of 56.5 square kilometers and is bordered on the south and southwest by Mount Makiling, on the north by Laguna de Bay, on the northwest by Calamba City and on the east by the town of Bay. The town is located 63 kilometers southeast of Manila and is accessible via the South Luzon Expressway [14].

**Bay:** Bay is one of the oldest towns in Laguna province; it is a second class municipality with a population of 55,698 with an area of 42.66 square kilometer. Its original territory covered the areas that are now known as Los Baños and Calauan (in addition to its current territory). There are 15 barangays and it belongs to the second district of Laguna [14].

In terms of economic profile, in agriculture, major commodities grown in the municipality are rice, coconut, lanzones, citrus, rambutan and crop vegetables. In livestock (2006 population data), it primarily produces poultry (56,016); ducks (13,878); swine (920); cattle (341); and carabao (29). Aside from that, fish production/fishing is the major source of income of the coastal barangays (San Antonio, Tagumpay and Sto. Domingo) [14].

**Victoria:** Victoria is a fourth class municipality in the province of Laguna. It is southeast of Laguna de Bay, 90 km south of Manila and bordered by the Municipality of Calauan to the southwest, Nagcarlan

to the southeast and Pila to the northeast. The municipality has a total land area of 22.83 square kilometres which is 1.30% of the total land area of the province of Laguna. After Pateros, Metro Manila became highly urbanized and densely populated; Victoria became a destination of balut traders and became the Duck Raising Center of the Philippines. The town of Victoria, which borders Laguna Lake, is known for the Itik Festival, held every second week of November. Nowhere else is the P5.5-billion duck industry more vibrant than in this municipality of 30,000. In 2003, the Philippines produced 54 million kilos of duck eggs and the same volume of duck meat. Total duck egg production amounted to P2.5 billion while the combined duck meat output grossed P2.93 billion. [15].

### Selection of respondents

The respondents of the study were the owners of the duck egg production business. They were interviewed using an interview schedule questionnaire.

### Sample selection

For the food safety component, a total of 15 duck egg samples were selected from the three large-scale production sites in Los Banos, Bay and Victoria, Laguna using convenience sampling technique.

### Research design

The study followed a descriptive research design. In the assessment of the safety of duck egg for consumption, completely randomized design was followed.

### Analysis of sample

Duck egg samples were coded as Sample A, B and C. The unknown amounts of Pb in duck egg samples were explored using Atomic Absorption Spectroscopy (AAS). The chemical analysis was conducted at the BIOTECH Laboratory, UP Los Banos, Laguna.

### Scope and limitation

The study was limited to analysis of the Pb content of raw duck eggs from three large-scale production sites at the lakeside towns of Laguna de Bay. Other heavy metals such as mercury and cadmium as well as duck egg processed products were not included in the study due to budget constraint. Moreover, factors such as maturity of eggs and season of harvest of eggs that may confound the analysis were not considered in the study due to time constraint.

## Results and Discussions

Details of farm practices on duck raising, processing and marketing of eggs and other duck-based products in Laguna Lake areas were determined in the study.

Duck raising in Laguna lake areas is said to be a matured and established industry in terms of years of its existence based on that number of years or decades that each respondent started their farming operation. All of the respondents inherited the business from their parents and relatives. Duck egg production and processing originally started in Pateros that once known as duck capital in the country. But when this became highly urbanized and densely populated duck raisers and traders migrated to Laguna and it became the destination of duck egg trading, notably, *balut* and *penoy*. Today, Victoria in Laguna became the Duck Raising Center of the Philippines Cadizduckfarm.com [16].

Ducklings that are raised as breeders and layers come from local

hatcheries in Los Banos and Victoria. There are bigger farms that have their own established breeding facilities to cater bigger number of eggs to hatch for trading purposes.

The number of birds raised ranged from 800 to 45,000 heads. These are categorized as backyard to commercial scale business enterprise. These numbers according to the respondents are smaller compared in the past years. The shortage of supply of natural foods from the lake, like snails; high cost of commercial feeds; and the lack of successor who will manage the business were some of the reasons cited. Moreover, the average volume of egg production per day/farm for Los Banos, Bay and Victoria Laguna were 500, 690, and 10,000, respectively, which is equivalent to 22-62%.

### Feeding practices

Feeding practices in terms of feed composition, ration, style of feeding, feed preparation and others, vary from farm to farm. Commonly, chopped shrimps combined in boiled rice, freshwater snails [10]; banana peelings as source of protein, fat and fibers, calcium and little of phosphorous; cassava and camote, for better egg production [11] kangkong, ipil-ipil and legumes [10] are the variety of natural food material that can be given from day old to growing stages of ducks.

In Laguna, each farm also has its own way of feeding their ducks. The only aspect of feeding that is common to all is the giving of freshwater snail. Like in Los Banos, 30 cans of snails are given to ducks (500 heads) every morning as supplemental food, other than the commercial feeds (10 kg), which is mixed with desiccated coconut (*sapal*) and fine rice particles (*binlid*) in smaller amount, to be fed to ducks 3 times a day.

While in Bay and Victoria, Laguna, ducks are fed mainly with commercial diet and snails in a ratio of 2.3 bags of feeds to 16 sacks of snails for their 4,000 heads of ducks. However, to supplement and economize on feeds, owner of the farm brought their ducks in their own rice fields nearby after harvesting season to feed on remaining *palay* and snails.

Generally, backyards to small-scale duck farms usually are using those commercial feeds that are available in their local market. Gatherers from Laguna de Bay, particularly in the areas of Sta. Rosa, Bay, Calamba and Sta Cruz, supplied the needed snail.

### Processing

In practice, duck raisers usually perform processing along with egg production. Farms in Los Baños and Victoria both produce and process eggs. The producer in Los Baños does not sell their eggs but made them all into salted eggs for the local and supermarket consumption in wholesale basis. The processing schedule is twice a week.

The same practice is followed in the farm in Victoria. However, other than salted eggs that make-up the bulk of their processing activities, they are also producing *balut* and *penoy*; and sell fresh eggs, too. Processing is done daily and the volume of eggs they process is based on the amount that outlets can consume. This is to ensure the freshness and good quality of their products.

While in other farm in Bay, is engaged only in egg production probably due to some practical reasons. Their daily production of 2,800 eggs is picked-up by balut and salted egg producers from Mayondon, Los Baños and Tagumpay, Bay, in wholesale basis.

### Food safety of duck eggs based on Pb content

Pb is an environmental contaminant that occurs naturally and,

to a greater extent, from anthropogenic activities such as mining and smelting and battery manufacturing. It is a metal that occurs in organic and inorganic forms; the latter predominates in the environment. Food is one of the major sources of Pb exposure; the others are air (mainly lead dust originating from petrol) and drinking water. Plant food may be contaminated with Pb through its uptake from ambient air and soil; animals may then ingest the lead-contaminated vegetation. In humans, lead ingestion may arise from eating lead-contaminated vegetation or animal foods. Another source of ingestion is through the use of lead-containing vessels or lead-based pottery glazes. In humans, about 20 to 50% of inhaled, and 5 to 15% of ingested inorganic lead is absorbed. In contrast, about 80% of inhaled organic lead is absorbed, and ingested organic Pb is absorbed readily. Once in the bloodstream, lead is primarily distributed among blood, soft tissue, and mineralizing tissue [12]. The bones and teeth of adults contain more than 95% of the total body burden of lead. Children are particularly sensitive to this metal because of their more rapid growth rate and metabolism, with critical effects in the developing nervous system [13].

The results of the study showed that the lead concentrations of raw duck eggs from the three large-scale production sites were 0.20 mg/kg Fresh Weight (FW), 0.22 mg/kg FW and 0.20 mg/kg FW for samples A, B and C, respectively. The mean lead content was 0.21 mg/kg FW. This value was higher than the Pb content of water spinach grown near domestic areas alongside Laguna de Bay which is 0.02 mg/kg FW [11]. Essentially, this value is found higher than the mean Pb content of eggs in developed countries which is 0.02 mg/kg FW [17]. It is however lower when compared with the maximum Pb concentration in solid foods, that is, 6 mg/kg [17]. Using the maximum tolerable daily intake of Pb for adult set by the WHO which is 0.21 mg/kgBW as reference, it can be considered that developing Pb toxicity from the intake of duck eggs over a short period of time is highly impossible [19].

Long term consumption of any foods containing heavy metals can lead to development of health problems through the process of bioaccumulation. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time [19]. They tend to accumulate in living things when they are taken up and stored faster than they are broken down (metabolized) or excreted [12,19].

With this, foods must be selected carefully. Food sources must be assessed for potential contamination including heavy metal contamination. Also, moderation and variety as principles of healthy eating must be well taken into account. Increased dietary exposure or frequent consumption of food containing heavy metal means higher level of exposure and therefore, greater chance of developing health hazards.

The presence of Pb could be possibly caused by lead contamination at any points of food production. Aquatic feeds such as snails and shells from Laguna Lake as well as commercial feeds may contain heavy metals like Pb. It is recommended that further test be performed to duck eggs. The assessment of other heavy metals is important to ensure the safety of the public. Duck feeds such as snails as well as commercial feeds could also be assessed for the following metal to correlate the data obtained. Precision and accuracy analysis could be done by considering confounding factors such as maturity of eggs and season of harvest to increase the robustness of the results.

### Conclusions and Recommendations

Duck raising is a lucrative business with the range of production from 500 per day to 45, 000 per day contributing to livelihood creation

and economic growth. The food safety assessment of duck eggs produced in areas along Laguna Lake revealed that the mean lead content is 0.21 mg/kg FW. Essentially, this value is above the mean lead content of eggs in developed countries which is 0.02 mg/kg FW [17]. Using the maximum tolerable daily intake of Pb for adult set by the WHO (2001) which is 0.21 mg/kgBW as reference, it can be said that the maximum tolerable daily intake of Pb would be reached when one (1) kilo of duck eggs are taken in one day which is far from the normal eating capacity of a person per day. Though acute poisoning from lead less likely, its long term consumption can pose health hazards through the process of bioaccumulation. Decreasing dietary exposure through careful selection of foods and incorporating the principles of variety and moderation in the diet can lessen the health risks associated with heavy metal contamination.

The presence of Pb in duck eggs could be possibly caused by lead contamination at any points of food production, with aquatic feeds such as snails and shells from Laguna Lake as potential sources. It is recommended that further test be performed to duck eggs. The assessment of other heavy metals is important to ensure the safety of the public. Duck feeds such as snails as well as commercial feeds could also be assessed for the following metal to correlate the data obtained. Precision and accuracy analysis could be done by considering confounding factors such as maturity of eggs and season of harvest to increase the robustness of the results.

Additionally, health risks in food production are a major concern that must be considered. Feeds and food sources must be studied and proven safe for consumption.

Taken collectively, this food safety assessment only shows that what humans are doing to the environment can adversely affect the health of the humanity, hence, a sound policy that may reduce this environmental health risks should be administered.

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