International Journal of Agricultural Technology 2022Vol. 18(2):917-926
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Egg production, quality, and hatchability rates of Philippine ducks (*Anas luzonica*) in response to low-cost cassava-based rations

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Villaver, J. P., Zacal, A. L., Gabaya, N. E. and Cantila, M. L. (2022). Egg production, quality, and hatchability rates of Philippine ducks (*Anas luzonica*) in response to low-cost cassava-based ration. International Journal of Agricultural Technology 18(2):917-926.

Abstract It is the firstly reported the effects of cassava-based ingredients at the inclusion of 30 to 40% (cassava meal and cassava leaf meal) on the overall ducks' egg performance, quality, and hatchability. The different treatments significantly impacted the ducks' egg production and quality parameters except for the hatchability rates (df=4, 8; F=0.42; P=>0.05). Treatment 4 (pure commercial feeds) produced the highest number of eggs per year (df=4, 8; F=29.36; P=000) at 277 and followed by treatment 5 (farmer-based formulation and commercial feeds [1:1 ratio] at 200. In terms of the quality parameters, the ducks in treatments 1 (30% cassava-based ration), 2 (35% cassava-based ration), and 3 (40% cassava-based ration) produced medium eggs with 31.74%, 27.01%, and 28.52%, respectively. The ducks yielded extra-large eggs in treatment 4 at 37.68% and treatment 5 at 40.69%. Treatment 4 produced the heaviest weight per egg at 60.0 g (df=4, 8; F=8.13; P=<0.01) while Treatment 2 produced the heaviest shell at 11.0 g (df=4, 8; F=6.68; P=<0.05). The egg performance of ducks fed with cassava-based materials is not comparable to those fed with pure commercial feeds and a combination of farmer-based formulation with commercial feeds (1:1 ratio). Further study is recommended to increase the study duration to three months to attain the peak of egg production, especially for the cassava-based ration-fed ducks.

Keywords: Ducks, Egg production rate, Egg quality, Hatchability, Cassava-based ration

Introduction

Duck raising is a profitable livelihood enterprise for the farmers to earn more income from its eggs and meat. Ducks are very flexible animals for their diets since they can consume leftovers, plant leaves, golden snails, and insects along the way as they swim in the ponds and explore rice fields after harvest. Duck is a very tame animal whose caretakers can easily drive them home

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during and after ranging time. The caretaker collects eggs every morning and prepares them for sale to the egg retailers and "balut" producers. Duck can produce an average of 234 eggs per year (Debnath *et al*., 2020), depending upon their diets and stress-related factors like the conditions of the environment and weather patterns.

According to (PSA, 2020), as of January 1, 2021, the country's duck inventory was estimated at 12.22 million birds, where 65.5% of them were backyard farms, and 34.5% were commercial farms. Gutierreza (2019) pointed out that the Zamboanga Peninsula produced only 2% of duck eggs based on the data taken from the Philippine Statistics Authority. Balut is one of the most important products in the duck industry. The demand for balut is increasing because it is a very important food delicacy of Filipino people. The consumers preferred to eat balut during nighttime. Consumers eat balut before or after their regular meals. Balut is an affordable and nutritious food containing more vitamins, proteins, lipids, and fats (Gul *et al*., 2021).

There is a need to increase its production while lowering its feed cost to add more profits. Pawariya and Jheeba (2015) found that 68.4% of the total production cost for layers goes to feed cost. Lambio (2000) said that the government gives feed technology more important to attain a realistic duck industry. Finding alternative feed ingredients to replace conventional feed sources will lessen the feed cost (Abro *et al*., 2020). To reduce feed costs, the duck raisers usually include kangkong (*Ipomoea Aquatica*) and commercial feeds (1:1). Other ingredients that are believed to reduce the feed cost include cassava roots and leaves in the ration. Adding cassava-based in the feed formulation would lessen the feed cost while boosting ducks' egg production for the balut industry. Cassava is produced locally by the farmers in the Province of Zamboanga del Sur. Therefore, there would be a continuous supply of cassava roots throughout the season. The cassava root is rich in carbohydrates (Jackson and Chiwona-Karltun, 2018), while the leaves are rich in protein, vitamins, and minerals (Latif and Müller, 2015). Hydrocyanic acid is a limiting factor in cassava (Ndubuisi and Chidiebere, 2018); however, it can be reduced or eliminated through the extruding method (Omeire *et al*., 2012). This experiment endeavored to determine the low-cost formulation influencing Philippine ducks' egg production, quality, and hatchability rates.

Materials and methods

The study was conducted at the Zamboanga del Sur Organic Research and Development Center, Switch, Ramon Magsaysay, Zamboanga del Sur, Philipines, from December 2020 to February 2020, covering 60 days.

A total of 345-layer stage ducks were used in the study for 60 days rearing period. Each cage consisted of 20 females and three males. The rearing pens were arranged in a randomized complete block design (RCBD) with five treatments and three replicates. The treatments were formulated as follows T_1 – 30% cassava-based ration; T_2 – 35% cassava-based ration; T_3 – 40% cassava-based ration; T_4 – pure commercial feeds; and T_5 – farmer-based formulation and commercial feeds (1:1 ratio).

The experimental house had 15 compartments, enough to accommodate the needed number of ducks for the experiment. Each compartment measured 4 meters wide, 3.3 meters long, and 3 meters high with a uniform floor area. Bamboo sticks were used as a fence to serve as a division of the compartments. Cassava tubers and leaves were produced by the local farmers in partnership with the local government unit (LGU) to ensure a continuous supply of materials within the project's duration. Other ingredients such as rice bran, yellow corn, soya meal, fish meal, and copra meal were outsourced from the local agrivet suppliers in the province.

Cassava roots were washed and grated using a cassava grater. Cassava grates were placed in the cassava grate spinner to extract the water and hydrocyanic acid content. A pulverizer was used to produce cassava mash before drying. A rotary drum dryer was used to attain 13% moisture content.

Mixing of feeds using a mini-feed mill was done once every two weeks to avoid additional application of anticoagulants and other preservatives. Feed rations were pelletized using a pellet mill at a diameter of 4.76 mm. Regular feeding of the layers was strictly followed by a ratio of 1.68 kg in weight. The experimental animals were provided ration and water twice per day, morning and afternoon.

Ducks lay their eggs during the night and early morning. Eggs were collected every morning then placed in the plastic filler trays. Dirty eggs were cleaned immediately after collection to avoid infection. Eggs were sorted into peewee, small, medium, large, extra-large, and jumbo using an egg weighing scale. The incubator was run for a day before placing the suitable eggs to test if they were functional. Suitable eggs were collected at random and placed in the incubation room with adequate ventilation and constant temperature. Eggs were placed with pointed ends down to the incubator trays. Eggs were hatched at an average of 28 days. Humidity was controlled by adjusting the ventilators of the machine and the moisture trays. The incubator was run at a minimum of 37 ºC and a maximum of 37.8 ºC. Eggs were turned through an angle of 90 degrees. Turning of eggs was performed manually four times at 7:30 AM, 11:30 AM, 2:30 PM, and 5:30 PM starting the day of settling the eggs in the incubator.

Embryonic development of eggs was monitored on the 7th, 10th, and 14th day by shining an electric light. A live embryo and blood vessels were seen containing dark spots in the large end of the egg. Infertile eggs are those with clear or with dark spots stuck to the shell membrane. After the fertility test, the infertile eggs were removed from the incubator. After 26 days in the incubator, the eggs were brooded and transferred to the hatchery.

The data gathered in this study were the number of eggs, egg sizes, the weight of eggs, weight of eggshell, weight of albumen, weight of egg yolk, number of fertile eggs, and hatchability rates. Data were analyzed using analysis of variance (ANOVA) in RCBD using Minitab 17. Treatment differences were compared using Tukey's test. Multivariate analyses were done to determine the relationships of some egg production, quality, and hatchability parameters. Weighted arithmetic mean was used to determine the most common egg size produced per treatment.

Results

Number of eggs at 15, 30, 45, and 60 days of rearing

The number of eggs produced by 20 ducks at 15, 30, 45, and 60 DOR is presented in Table 1. The data showed that the ducks fed with commercial feeds produced the highest number of eggs at 237.7, 233.0, 226.0, and 215.3 from 15, 30, 45, and 60 DOR, respectively. Treatment 5 (farmer-based ration + commercial feeds 1:1) produced the lowest number of eggs at 72.3 during the first collection at 15 DOR; however, a gradual increase was observed at 30 DOR (183.0), 45 DOR (195.0), and 60 DOR (208.0). The number of duck eggs in treatment 5 was comparable to that produced in treatment 4 (commercial feeds) at 45 DOR. On the other hand, the ducks feed with cassava-based rations in treatments 1, 2, and 3 produced an average number of eggs with 128.3, 128.0, and 122.0, respectively, during 15 DOR, and a gradual increase was observed at 30 DOR. It was observed that there was a significant reduction in egg production at 45 DOR when fed with cassava-based ration. Later, at 60 DOR, ducks fed with 35% cassava-based ration showed a slight increase, although they were not comparable to ducks fed with commercial feeds with stable egg production.

Egg production rate (%)

The trend of egg production rates at 15-30, 30-45, and 45-60 DOR is shown in Figure 1. It revealed that treatment 5 got the highest rate at 15-30 DOR. In the first 15 DOR, the ducks were still in the process of adjustment to the feed ration given. The significant positive increase of the egg production rates at 15-30 DOR in treatment 5 was due to the early response on the adaptability of the ducks to the farmers' formulated ration with commercial feeds. Treatments 1, 2, and 3 with cassava-based formulation showed a slight increase during 15-30 DOR, and then suddenly, the production dropped during 30-40 DOR. However, ducks fed with cassava-based ration showed a significant positive increase during the 45-60 DOR. This trend showed that the ducks started to adapt the ration with the cassava-based ingredients, producing more eggs. Stability on the production of eggs was observed in treatment 4 from 15-30, 30-45, and 45-60 DOR. Egg productions in treatment 5 were also stable at 30-45 and 45-60 DOR.

Table 1. Number of eggs produced by ducks at 15, 30, 45, and 60 DOR as influenced by cassava-based rations

Treatments	Rearing Periods			
	15 DOR	**30 DOR**	**45 DOR**	**60 DOR**
T1-30% Cassava-based ration	128.3^{b}	173.3^{b}	79.7^{b}	129.0^{c}
T2-35% Cassava-based ration	128.0^{b}	148.7^{bc}	99.3^{b}	151.7^{abc}
T3-40% Cassava-based ration	122.0^{b}	125.3^{c}	80.0^{b}	134.7^{bc}
T4-Pure commercial feeds	237.7^{a}	233.0^{a}	226.0^{a}	215.3^{a}
T5-Farmer-based ration and commercial feeds (1:1)	72.3^{c}	183.0^{b}	195.0^{a}	208.0^{ab}
F-tests				
Treatments	**	**	**	**
Replications	ns	ns	ns	ns

Notes: Means having the same letter are not significantly different from each other. ** - significant at 1% level of significance, ns – not significant

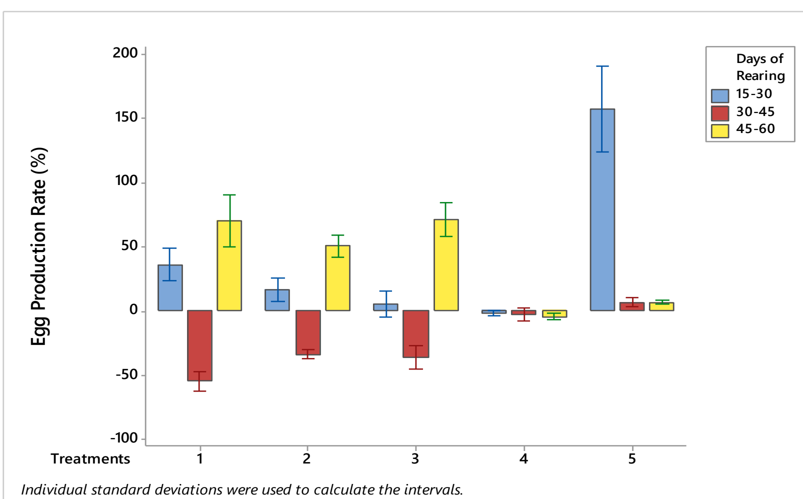

Figure 1. Egg production rate at 15-30, 30-45, and 45-65 days of rearing (DOR) as influenced by cassava-based ration

Eggs per year

The ducks in Treatment 4 produced the highest average eggs per year at 277.4, which is followed by treatment 5 at 200.24 (Figure 2). The ducks in treatment 3 (40% cassava-based ration) produced the least average at 140.52. The average number of eggs produced in treatments 1 and 2 were not far from treatment 5 but statistically not comparable to treatment 4.

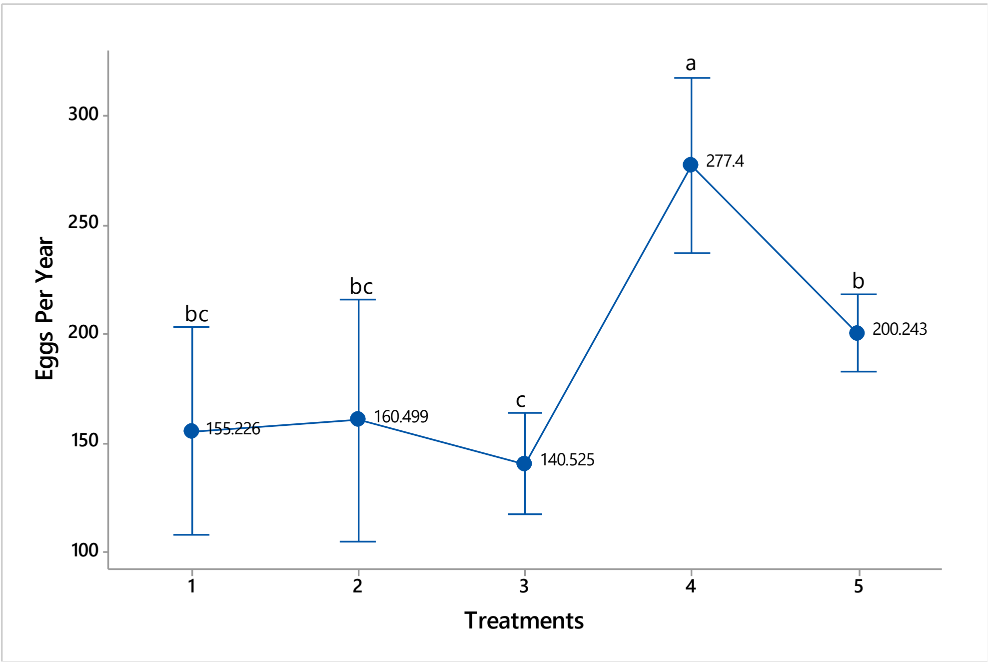

Figure 2. Egg production per year as influenced by cassava-based ration

Percentage of eggs produced according to each size from 0-60 DOR

The eggs produced by ducks to each size in percentage is shown in Figure 3. It showed that treatments 1, and 2, produced medium and small sizes of eggs. Treatment 3 produced medium and large sizes of eggs. Treatments 1, 2, and 3 rarely produced jumbo size of eggs. Treatments 4 and 5 produced mostly extra large and large sizes of eggs. Treatments 4 and 5 occasionally or a very few percentages of peewee occurred at 0-60 DOR.

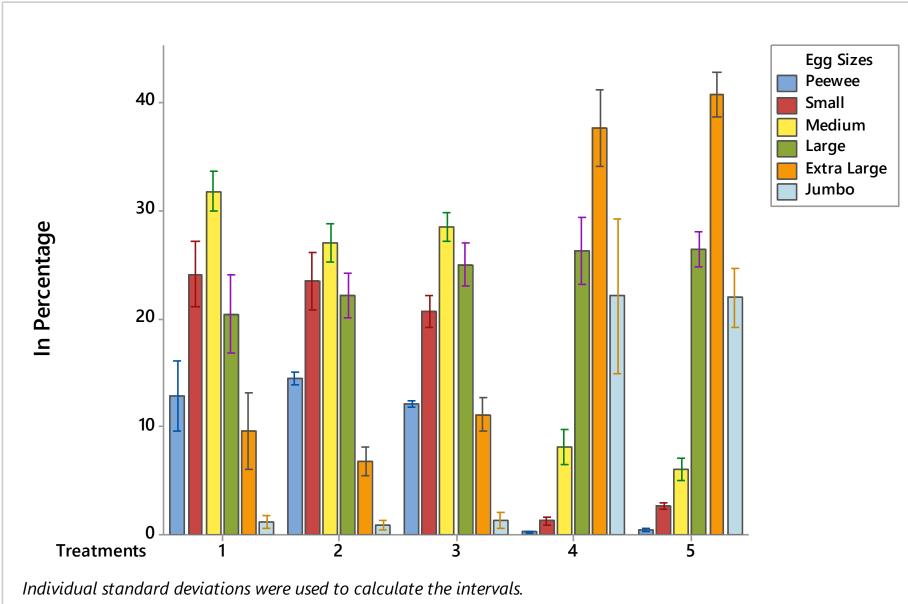

Figure 3. Percentage of eggs produced according to sizes as influenced by cassava-based ration

The heaviest weight per egg is shown in Table 2. The ducks fed with pure commercial feeds produced the heaviest weight per egg of 66.7 g. It was followed by Treatment 2 (35% cassava-based ration) and Treatment 5 (farmer-based ration + commercial feeds 1:1) with 60.0 and 58.0 g., respectively. The heaviest shell was attained on Treatment 2 at 11.0 g and closely followed by Treatments 1, 4, and 5. Statistical analysis did not show any significant differences in the weight of egg yolk and albumen in all treatments.

Table 2. Weight of egg, egg yolk, shell, and albumen (g) as influenced by cassava-based rations

Treatments	**Weight (g)**			
	Whole Egg	**Egg yolk**	**Shell**	**Albumen**
T1-30% Cassava-based ration	54.3^{b}	17.3	9.3^{ab}	27.7
T2-35% Cassava-based ration	60.0^{ab}	18.7	11.0^{a}	23.7
T3-40% Cassava-based ration	53.3^{b}	16.3	7.7^{b}	29.0
T4-Pure commercial feeds	66.7^{a}	18.0	9.7^{ab}	39.0
T5-Farmer-based ration and commercial feeds (1:1)	58.0^{ab}	18.0	9.3^{ab}	30.7
F-tests				
Treatments	**	ns	**	ns
Replications	ns	ns	ns	ns

Notes: Means having the same letter are not significantly different from each other. ** - significant at 1% level of significance, ns – not significant

Number of fertile eggs at 7, 10, and 14 DOR

The number of fertile eggs at different incubation periods at 7, 10, and 14 DOR ios shown in Table 3. It showed that the most fertile eggs were observed in the ducks fed with a 35% cassava-based ratio during the 7th and the 10th incubation period. At 14th DOR, treatments 2 and 4 got the most fertile eggs of 25 in each. Statistical analysis did not reveal any significant differences in the number of fertile eggs at 7, 10, and 14 DOR.

Table 3. Number of fertile eggs at different incubation periods at 7, 10, and 14 DOR as influenced by cassava-based rations

Treatments	**Incubation Periods**		
	7 DOR	**10 DOR**	**14 DOR**
T1-30% Cassava-based ration	24.33	24.00	23.67
T2-35% Cassava-based ration	27.33	27.00	25.00
T3-40% Cassava-based ration	26.33	25.00	23.67
T4-Pure commercial feeds	26.67	25.33	25.00
T5-Farmer-based ration and commercial feeds (1:1)	22.33	21.00	20.33
F-tests			
Treatments	ns	ns	ns
Replications	ns	ns	ns

ns – not significant

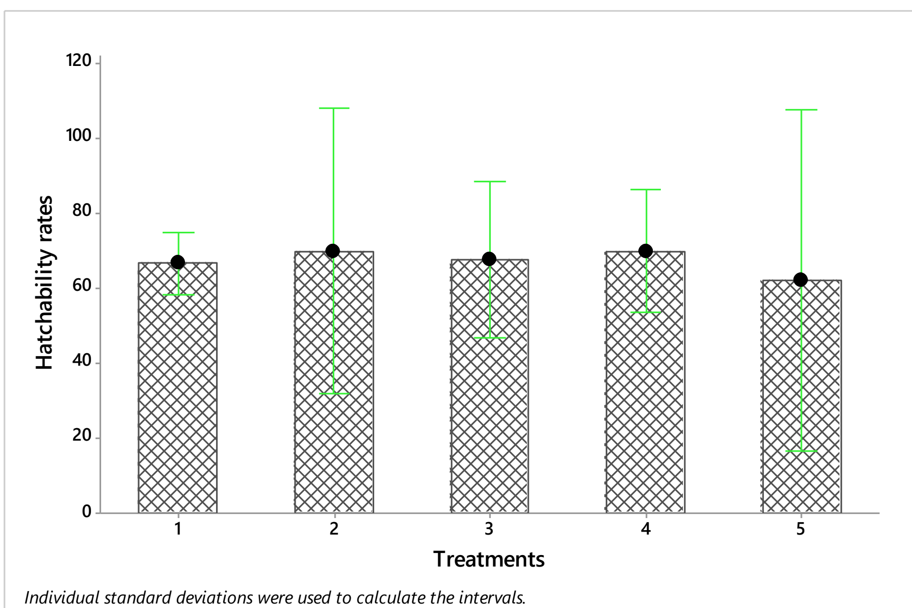

Figure 4. Hatchability of eggs as influenced by cassava-based ration

Hatchability

The hatchability of eggs is presented in (Figure 4). It showed that all treatments did not significantly influence the hatchability of eggs. Therefore, feeding the ducks with cassava-based ration is still has potential for the retention of fertility and viability of eggs since the result was comparable to pure commercial feeds.

Discussion

Cassava roots and leaves are important ingredients in lowering the feed cost since they can be grown and produced by farmers, even in marginal areas. There were 20 ready to lay egg females and three males in each compartment to ensure proper production. This study showed that during the first egg collection at 15 DOR, treatment 4 (pure commercial feeds) produced the highest number of eggs. Ducks fed with cassava-based materials produced a lesser number of eggs. Cassava roots and dried leaves are good feed ingredients to lower feed cost (Lambio, 2000). Fish cassava silage can substitute corn and fish meal as a source of protein (Sulaeman, 2009). Morgan and Choct (2016) mentioned that cassava roots and leaves are very potential diets in poultry animals; however, little caution in mixing ingredients should be considered due to the limiting factors found in the roots and leaves, such as cyanide, tannin, and phytin. That is why duck eggs production is affected and reduced, especially at 45 DOR, where mixing is not fully perfected. The study of (Lei *et al*., 2017) suggested using cassava root meal at 20% without detrimental effects on the egg production and quality of layers. An increase in egg production rates was observed at 45-60 DOR when fed with cassava-based ration. At this stage, the ducks started to adapt to the inclusion of cassava-based ingredients. The study of (Sumiati *et al.*, 2020) reported that a 10% inclusion rate of cassava leaf meal improved the overall egg performance of ducks. Cassava leaf meal and palm kernel meal at 18% inclusion improved the quality of duck eggs (Nova *et al.*, 2021). Cassava meal at 40% inclusion rate improved the layers' egg quality and overall performance (Okereke *et al*., 2008).

Therefore, it is concluded that cassava-based rations were not comparable to the commercial feeds in terms of egg production and sizes. However, cassava-based rations proved to be the potential to improve the quality of eggs in terms of increasing the shell thickness. Cassava roots and leaves contain vitamins and minerals, particularly calcium and phosphorus, which help develop eggshells (Montagnac *et al*., 2009). If further study is conducted, it is recommended to increase the duration of the study up to nine months to attain the peak of egg production for the cassava-based treated birds.

Acknowledgements

The author would like to offer particular thanks to the Zamboanga del Sur Provincial Government College, Provincial Agriculture Office, Pagadian City, and the Department of Agriculture – IX for the support of this study.

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(Received: 15 September 2021, accepted: 27 February 2022)