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Utilization of Coconut Shell Liquid Smoke on Quail Performance at Grower Period

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ABSTRACT

Antioxidants from coconut shell liquid smoke can overcome oxidative stress in quail. This study aims to analyze the effect of coconut shell liquid smoke (ACTK) on the performance of quail (*Coturnix coturnix japonica*) during the grower period. The research method used a completely randomized design consisting of 5 treatment levels with 3 replications, namely P0 (control), P1 (0.25 mL/L ACTK), P2 (0.50 mL/L ACTK), P3 (0.75 mL/L ACTK) and P4 (1 mL/L ACTK). Variables measured included initial body weight, final body weight, body weight gain, feed intake, water intake, feed conversion ratio (FCR), morbidity, mortality, and income over feed quail cost (IOFQC). The results showed that giving ACTK had no significant effect (P>0.05) on feed intake, water intake, and body weight gain. The morbidity and mortality rates in this study were 0%. The best FCR value was obtained at P4 (4.28). The highest IOFQC value was at P4 (Rp 1.578,92). This study concludes that giving coconut shell liquid smoke to female quails during the grower period through drinking water had no significant effect on feed intake, water intake, and body weight gain. A dose of 1 mL/L of ACTK produced the best FCR and IOFQC values.

Keywords: antioxidants, coconut shell, liquid smoke, quail

ABSTRAK

Pemberian antioksidan dari asap cair tempurung kelapa dapat mengatasi stres oksidatif pada puyuh. Penelitian ini bertujuan menganalisis penggunaan asap cair tempurung kelapa (ACTK) terhadap produktivitas puyuh (*Coturnix coturnix japonica*) periode *grower*. Metode penelitian menggunakan rancangan acak lengkap yang terdiri dari 5 taraf perlakuan dengan 3 ulangan yaitu P0 (kontrol), P1 (0.25 mL/L ACTK), P2 (0.50 mL/L ACTK), P3 (0.75 mL/L ACTK) dan P4 (1 mL/L ACTK). Variabel yang diukur meliputi bobot badan awal, bobot badan akhir, pertambahan bobot badan, konsumsi pakan, konsumsi air minum, *feed conversion ratio* (FCR), morbiditas, mortalitas dan *income over feed quail cost* (IOFQC). Hasil penelitian menunjukkan pemberian ACTK tidak berpengaruh nyata (P>0.05) terhadap konsumsi pakan, konsumsi air minum, dan pertambahan bobot badan. Tingkat mobiditas dan mortalitas pada penelitian 0%. Nilai FCR terbaik diperoleh P4 (4.28). Nilai IOFQC tertinggi pada P4 (Rp 1.578,92). Kesimpulan penelitian ini adalah pemberian asap cair tempurung kelapa pada puyuh betina periode *grower* melalui air minum dengan taraf yang berbeda tidak berpengaruh terhadap konsumsi pakan, konsumsi air minum dan pertambahan bobot badan. Dosis 1 mL/L air minum asap cair tempurung kelapa menghasilkan nilai FCR dan IOFQC terbaik.

Kata kunci: antioksidan, asap cair, puyuh, tempurung kelapa

INTRODUCTION

Indonesian people need animal protein from livestock which has a relatively fast production cycle in producing meat, milk, and eggs. The quail is one type of livestock with a quick production cycle for eggs. Quail begins to lay off 42 days, egg weight is 8-11 grams and the average production is 253-332 eggs per head per year (Al-Tikriti 2018; Narinc *et al*. 2013). Many factors, such as genetic strain, feed, management, and environmental temperature, have an impact on the productivity of quail.

Intergovernmental Panel on Climate Change (2021) states that environmental temperature increased by 1.5-2 ^{o}C during the 21st century. The rising temperature also has an impact on tropical nations like Indonesia as well. Data from Statistics Indonesia (2020) shows the lowest environmental temperature in Indonesia is 19 ^{o}C and the highest is 36 ^{o}C with an average temperature of 28 ^{o}C per year. The environmental temperature in Indonesia is above the comfort zone for poultry, including quail. Quail has a comfort zone of 18-21 ^{o}C (Wasti *et al*. 2020). This condition can lead to oxidative stress, which can impair quail performance. Oxidative stress is defined as an imbalance between oxidants and antioxidants (Surai *et al*. 2019). This oxidative stress can be overcome by antioxidants which function as an immune system against free radicals in quail (Tugiyanti *et al*. 2019). Indonesia has many sources of natural antioxidants with various active ingredients, including vitamins C, E, pro-vitamin A, flavonoids, statins, niacin, and phenols (Werdhasari 2014). One of the natural ingredients that has the potential to be an antioxidant is liquid smoke (Hatta *et al*. 2018).

Liquid smoke is the result of the decomposition process of biomass through the pyrolisis process (Abdullah *et al*. 2017). Agricultural and plantation wastes like rice husks, cocoa pod husks, coconut shells, and wood from industrial forest plants are the major components are used to make liquid smoke (Qomariyah *et al*. 2019). Coconut shell contains lignin, hemicellulose, and cellulose which are the main components of liquid smoke production (Surboyo *et al*. 2019). Liquid smoke contains organic substances such as acetic acid, alcohol, phenol, and other substances (Grewal *et al*. 2018). Phenol compounds are the result of lignin decomposition which are useful as antimicrobial, antifungal, and antioxidant agents (Beker *et al*. 2016). Coconut shell liquid smoke is known for its acidic nature, which is caused by a low pH level. According to Budaraga *et al*. (2016), the pH value of coconut shell liquid smoke ranges from 3.50-3.69 with a total acid 0.62-1.62%. Previous research has been conducted on the use of acid concentrations in poultry, and it has been found that the use of hydrochloric acid (HCL) in roosters at a level of 1 mL/kg of feed yields good results (Adeyina *et al*. 2009). Based on this information, this study tries to use coconut shell liquid smoke up to a level of 1 mL/L of drinking water.

Research studies have shown the positive effects of liquid smoke on poultry. Administration of liquid smoke through drinking water to a level of 1% provides optimal results for the immune system and reduces broiler mortality (Yosi and Sandi 2014). Liquid smoke from eucalyptus wood at a treatment level of 2.5% for broiler quail (*Colinus virgianus*) can increase body weight gain and improve feed conversion ratio (Diogenes *et al*. 2019). Additionally, Andy *et al*. (2022) discovered that providing liquid smoke encapsulation at a level of 1.5% produced the best performance and balance of intestinal microbiota. However, no research has been conducted on the effects of using coconut shell liquid smoke on quail performance during the grower period. This study aims to analyze the impact of coconut shell liquid smoke on quail (*Coturnix japonica*) performance during the growing and pre-laying period.

MATERIAL AND METHODS

Material

The equipment used in the manufacture of liquid smoke included pyrolysators, condensers, furnaces, distillate flasks, plastic bottles, paper, and pens. The tools used for quail maintenance included 5-level colony cages with dimensions of 100 cm length x 75 cm width x 180 cm height. These cages were partitioned with a length of 50 cm and each partition houses 10 quails. Additionally, feeders, waterers, lamps, and thermometers were also used. The primary material used in the production of liquid smoke is coconut shell waste collected from Dramaga Market, Bogor Regency. The animal used for this study comprises 150 female quails, fed with New Hope commercial feed. The nutrient content used can be seen in Table 1.

Table 1. New Hope P100 quail feed nutrient content

Nutrients	Contents (%)
Water content	13
Proteins	20
Fat	7
Crude Fiber	7
Ash	14
Calcium	2.5-3.5
Total Phosphorus	0.8-1.0
Lysine	0.9
Methionine	0.4
Methionine + Cystine	0.6

Source : PT. New Hope Indonesia

Methods

This research was conducted in two stages, firstly the production of coconut shell liquid smoke and secondly the raising of quail. The sample of coconut shell utilized weighed 3 kg and was required to meet the criteria of being strong, hard, and black. The coconut shell was broken and put into the pyrolysator. Coconut shells were pyrolyzed at 500 ^{o}C for 5 hours. During the pyrolysis process, coconut shells produce solid products in the form of charcoal and gas. The gas product condensed through a condenser, resulting in the production of liquid smoke that was stored in a distillate flask overnight. Quail rearing consisted of preparing the cage, recording environmental temperature, providing feed and drinking water. Cage preparation consisted of disinfecting and sanitizing, installing treatment labels on each cage plot, and providing

a space for feed, drinking water, and a 5-watt lamp. The environmental temperature was recorded every morning (06.00-07.00 WIB), noon (12.00-13.00 WIB), and evening (16.00-17.00 WIB). Feed was given twice a day, in the morning and evening. Drinking water mixed with coconut shell liquid smoke was only provided in the morning.

Observed Variables

Initial body weight was obtained by weighing quails in the grower period at the start of rearing (g). Final body weight was obtained by weighing quails in the grower period at the end of rearing (g). Body weight gain was obtained by subtracting the final body weight with the initial body weight (g). Feed intake was determined by subtracting the remaining feed from the total amount given (g head^{-1} day^{-1}). Water intake was calculated by subtracting the amount of leftover drinking water from the total amount of water throughout the day (mL head-1 day-1). Feed conversion ratio was calculated by dividing the feed consumed by body weight gain. Morbidity, is obtained by dividing the number of sick quails observed during the study by the initial number of quails and multiplying by 100%. Mortality was obtained by dividing the number of quails that died during the study by the initial number of quails during rearing and multiplied by 100%. Income over feed quail cost (IOFQC) was calculated by subtracting the income (sales of quail and eggs) and production costs (feed, treatment and purchase of quail).

Data Analysis

This study used a completely randomized design (CRD) with the treatment of adding coconut shell liquid smoke (CSLS) via drinking water. The treatment involved 5 different levels. Each level of treatment was repeated 3 times. The specific treatments used in the study were as follows:

P0: Drinking water without CSLS (control);
P1: Drinking water + CSLS 0.25 mL/L drinking water;
P2: Drinking water + CSLS 0.50 mL/L drinking water;
P3: Drinking water + CSLS 0.75 mL/L drinking water;
P4: Drinking water + CSLS 1 mL/L drinking water.

The mathematical model design according to Matjjik and Sumertajaya (2013) was:

$$Yij = \mu + Pi + \varepsilon ij$$

Information :
Yij : The observed value of the results of the-i treatment of the-j repetition
M : General average
Pi : The effect of the-i treatment level
Eij : Effect of error from the-i treatment to the-j replication

Data processing was carried out using the Microsoft Excel 360 program. The data was then analyzed using Analysis of variance/ANOVA. If the treatment had a significant effect, it was followed by Duncan's multiple comparison test. The Data of feed conversion, morbidity, mortality, and income over feed quail cost (IOQFC) variables were analyzed descriptively.

$$DMRT_{\alpha,} = R_{(\alpha, p, v)} \sqrt{\frac{KTG}{r}}$$

Information :
KTG : Mean square error
r : Number of trial repetitions
P : Number of experimental treatments
α : Significance level
v : Degree of freedom

RESULTS AND DISCUSSION

Environmental Temperature of Quail

Quail rearing temperature was observed every morning (06.00-07.00 WIB), noon (12.00-13.00 WIB), and evening (16.00-17.00 WIB). The results of these observations can be seen in Table 2.

Table 2. The temperature during quail rearing

Variables	Value (°C)
Morning	23-26
Noon	27-39
Evening	25-32

During quail rearing, the temperature ranged from 22-26 °C in the morning, 27-37 °C in the noon, and 25-32 °C in the evening. However, these temperatures exceed the comfort zone for quails. In fact, according to Wasti *et al*. (2020), the optimal temperature for keeping quail is 18-21 °C. This high temperature causes oxidative stress, which is an imbalance between free radicals and antioxidants in the body. Free radicals are atoms or groups of atoms with unpaired electrons that react with oxygen to create reactive oxygen species (ROS) (Puspitasari *et al*. 2016). ROS can react with proteins and lipids in cells, causing damage and mutations. ROS that reacts with proteins in DNA (Deoxyribonucleic acid) cause DNA strands to break and mutate. When ROS reacts with PUFA (polyunsaturated fatty acid) components, it can lead to lipid peroxidation. This can cause free radicals to become highly reactive, resulting in damage to body cells (Wibawa *et al*. 2020). This damage can disrupt organ function, leading to decreased immunity and lower quail performance. Identification of oxidative stress in quail, it can be observed from rectal temperature, feed intake, water intake, and the H/L (heterophils per lymphocyte ratio). Asri and Harissatria (2021) found that quail exposed to an environmental temperature of 31-32 °C experienced an increase in rectal temperature and water intake, as well as a decrease in feed intake. Moreover, Ardiani *et al*. (2019) discovered that exposing quail to an ambient temperature of 35-45 °C resulted in a higher heterophils per lymphocyte ratio.

Quail Performance

Observations of quail performance in this study included water intake, feed intake, body weight gain, feed conversion ratio, morbidity, and mortality. The results of these observations are presented in Table 3.

Table 3. Quail performance by administering coconut shell liquid smoke

Variables	P0	P1	P2	P3	P4
Water intake (mL/head/day)	61.62±4.92a	61.05±3.75a	63.54±2.91a	64.57±3.48a	62.92±4.70a
CSLS Intake (mL/head/day)	0	0.02	0.03	0.05	0.06
Feed intake (g/head/day)	18.31±0.07a	18.20±0.27a	18.29±0.22a	18.30±0.22a	18.21±0.38a
BWG (g/head/day)	4.07±0.09a	3.93±0.17a	4.18±0.12a	3.83±0.14a	4.29±0.39a
FCR	4.51±0.08	4.64±0.27	4.38±0.16	4.78±0.17	4.28±0.33
Morbidity (%)	0	0	0	0	0
Mortality (%)	0	0	0	0	0

Treatment with the same superscript was not significantly different (P>0.05); P0 = drinking water without coconut shell liquid smoke (CSLS), P1 = drinking water with CSLS 0.25 mL L^{-1}, P2 = drinking water with CSLS 0.50 mL L^{-1}, P3 = drinking water with CSLS 0.75 mL L^{-1}, P4 = drinking water with CSLS 1 mL L^{-1}; BWG = Body Weight Gain; FCR = Feed Conversion Ratio.

The use of coconut shell liquid smoke did not have a significant impact on water intake (P>0.05). This was caused by the homogeneity of age and the environmental temperature of quail rearing during the study. Factors such as age, feed quality, and environmental temperature can all affect water intake (Asri and Harissatria 2021). The average daily water intake during the study varied between 61.05 ± 3.75 to 64.57 ± 3.48 mL of $head^{-1}$ day^{-1} or equivalent to 3.41 times the average feed intake. Based on the study, the high-water intake by the quail indicates that they are experiencing oxidative stress. The temperature in the maintenance environment ranges from 23-39 ^{o}C, which is beyond the quail's comfort zone. To maintain the fluid balance in their body, quail experiencing oxidative stress will increase their water intake. According to Syaefullah *et al*. (2021), poultry typically consumes 1.6-2.2 times more water than feed at normal temperatures. Meanwhile, a study found that the coconut shell liquid smoke intake increased linearly with increasing doses, even though there was no significant difference in water intake.

The application of coconut shell liquid smoke did not have a significant effect on feed intake (P>0.05). This is because the feed had a consistent metabolic energy content and was kept at a stable temperature throughout the study (Mone *et al*. 2016). Additionally, the feed used in the experiment had a consistent amount of crude fiber, but the inclusion of coconut shell liquid smoke led to additional consumption of crude fiber. The coconut shell contains crude fiber components, such as cellulose, hemicellulose, and lignin. Through the process of carbonization, these components break down into phenolic compounds and acetic acid (Budaraga *et al*. 2016). However, quails cannot optimally utilize these compounds due to the absence of cellulase enzymes in their digestive tract, hindering their ability to digest crude fiber (Hudiansyah *et al*. 2015). Moningkey *et al*. (2019) also noted that crude fiber's bulky nature, consisting of cellulose, hemicellulose, and lignin, can affect feed consumption and make it difficult for birds to digest. During the study, the average quail feed intake ranged from 18.20 ± 0.27 to 18.31 ± 0.07 g $head^{-1}$ day^{-1}, which is a relatively standard feed intake value. According to Florana *et al*. (2017), the average quail feed intake during the growing period was 18.33 g $head^{-1}$ day^{-1}.

The study found that there was no significant difference in body weight gain (BWG) (P>0.05) due to the same quality and quantity of feed intake. Utomo *et al*. (2014) reported that body weight gain was influenced by the quality and quantity of feed intake. Since the energy and protein content in the feed intake was uniform, it did not influence body weight gain. Gaol *et al*. (2015) also mentioned that the balance of energy and protein according to quail needs does not affect body weight gain. The quantity of feed intake was relatively similar for all treatments, leading to no statistical difference in body weight gain. Widyastuti *et al*. (2014) observed that body weight gain was correlated with an increase in feed intake.

In this study, quail treated with coconut shell liquid smoke at a level of 1 mL in drinking water (P4) achieved the best average feed conversion ratio (FCR) value of 4.28. The average FCR values in this study ranged from 4.28 ± 0.33 to 4.78 ± 0.17. FCR numbers indicate how efficiently feed nutrients are absorbed. According to Bakrie *et al*. (2013), low feed conversion rates indicate more efficient in feed absorption. Additionally, low feed conversion is associated with increased body weight gain. Laksmita *et al*. (2015) further explained that feed conversion is closely related to feed intake and body weight gain. According to Tobing *et al*. (2021), coconut shell liquid smoke contains triterpenoid compounds that can decrease feed conversion. Additionally, Tribudi *et al*. (2021) found that triterpenoids have antimicrobial properties, which can eliminate harmful microbes in the digestive system and promote the growth of beneficial ones. The FCR results from this study aligned with the recommended FCR standards for quails during the growing period. Asiyah *et al*. (2013) reported that quails between 3-6 weeks typically had an average FCR ranging from 4.15-4.27. The FCR value for quails was higher during the growing period compared to the starting and laying periods. The FCR values for quails during the starting period ranged from 2.06-2.56 and for laying from 2.49-2.73 (Jahanian and Edriss 2015; Sari *et al*. 2020). The difference in FCR values of quails during different periods was due to the varied feed efficiency objectives. Feed efficiency was used for organ growth and development as well as body weight gain in the starting period, while in the laying period, it was used for egg production. The FCR value during the growing period was used for the maturation of reproductive organs or sexual maturity (Utomo *et al*. 2014).

Morbidity refers to the extent of diseases, injuries, and disorders in a population that can affect their health.

Table 4. Income Over Feed Quail Cost (IOFQC) during 3 weeks.

Variables	P0	P1	P2	P3	P4
Feed intake (g/head/day)	18.31±0.07	18.20±0.27	18.29±0.22	18.29±0.22	18.21±0.38
Feed cost (Rp/head)	2.883,83	2.866,50	2.880,68	2.882,25	2.868,08
CSLS cost (Rp/head)	0	525	1.050,00	1.575,00	2.100,00
Quail cost (Rp/head)	13.000,00	13.000,00	13.000,00	13.000,00	13.000,00
FBW (g/head)	157,8	157,2	163,6	160,47	162,47
Quail sale (Rp/head)	15.780,00	15.720,00	16.360,00	16.047,00	16.247,00
Egg production (Egg)	3	5	5	7	10
Egg sale (Rp)	990	1.650,00	1.650,00	2.310,00	3.300,00
IOFQC (Rp/head)	886,17	978,5	1.079,32	899,75	1.578,92

CSLS = coconut shell liquid smoke; FBW = final body weight

According to the findings, the morbidity rate observed during the study was 0%. The quail did not exhibit any signs of disease, such as watery eyes, lethargy, and tangled fur.

The term mortality refers to the number of deaths in a population. According to this study, the mortality rate was 0% for each control and treatment group. This demonstrated that the immune system of quails can be maintained and their health can be preserved with the use of coconut shell liquid smoke (Yosi and Sandi 2014).

During quail rearing from 3-6 weeks of age, all quails lay simultaneously. However, there was a difference in their productivity. Based on the results obtained, the quails produced 3 eggs (1.42%), 5 eggs (2.38%), 5 eggs (2.38%), 7 eggs (3.33%), and 10 eggs (4.76%) each for P0, P1, P2, P3, and P4. According to Bell *et al*. (2002), poultry entered a layer period once they had produced at least 5%. Meanwhile, quail can produce eggs once they have reached sexual maturity. Chimezie *et al*. (2017) that the age of sexual maturity correlated with egg production, as a quicker age of sexual maturity leads to a faster peak of production.

Income Over Feed Quail Cost

The results of calculating the value of Income Over Feed Quail Cost (IOQFC) for 3 weeks are presented in Table 4. The coconut shell liquid smoke cost was IDR 100.000/L or IDR 100/mL. The current price for the New Hope P100 quail feed was IDR 375.000/50 kg, hence the price for 1 g of quail feed was IDR 7.5/g. The current price of 1 egg is IDR 330/item, while the selling price of 1 quail (6 weeks) was IDR 15.000/150 g or IDR 100/g.

The IOFQC value is used to predict farmer income (Rahayu *et al*. 2021). All treatment levels (P1, P2, P3, and P4) had greater IOFQC values than the control (P0). This demonstrates that a higher level of treatment increases income linearly. This difference also occurred because the treated quail had a higher final body weight and produced more eggs than the control treatment. The best IOFQC value is P4 at IDR 1.578,92. This IOFQC value is supported by a low P4 feed conversion value. According to Widodo *et al*. (2019), feed conversion ratio and egg production have an impact on IOFQC.

CONCLUSION

Giving coconut shell liquid smoke to female quails in the grower period through drinking water at different levels did not have a significant effect on feed intake, water intake, and body weight gain. A dose of 1 mL/L of drinking water (P4) of coconut shell liquid smoke produced the best feed conversion ratio (FCR) and income over feed quail cost (IOFQC).

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