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Addition of Cricket Flour (*Gryllus* sp.) in the ration to increase the essential fatty acid content in Mirah chicken eggs

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ABSTRACT

The quality of chicken eggs is greatly influenced by the feed given to the chickens. Cricket flour (*Gryllus* sp) contains saturated fatty acids and unsaturated fatty acids. This study aimed to analyze the effect of adding cricket flour to feed on the content of essential fatty acids in Mirah chicken eggs. The Mirah chickens used in this study were 32 with an age of 8 months. The cage used in the study was a battery cage with a partition for each chicken. The cricket flour used was purchased online and comes from processed fresh crickets that are dried and ground into flour for feed mixture. This study used a Completely Randomized Design (CRD) consisting of four treatments. Each treatment was repeated 4 times and each replication with 2 Mirah chickens. The treatments used were 4 types, namely: P0 100% commercial feed, P1 Commercial feed + 4% cricket flour, P1 commercial feed + 8% cricket flour and P3 commercial feed + 12% cricket flour. The parameters measured were Daily Ration Consumption (DRC), percentage of Stearic Acid, Elaidic Acid, Linoleic Acid and percentage of Oleic Acid. Data were analyzed by analysis of variance (ANOVA) and differences between treatments were continued with Duncan's test. The results showed that the treatment had a significant effect ($P < 0.05$) on stearic acid but had no significant effect ($P > 0.05$) on other parameters, with these results it can be concluded that the addition of cricket flour up to 8% can reduce stearic acid.

Introduction

Food is a crucial element in meeting human nutritional needs. One essential component of food is animal protein, which plays a vital role in growth and development. Chicken eggs are an efficient, nutritious, and economical source of animal protein. Eggs are known to be rich in nutrients, including protein, fat, and various vitamins and minerals (Oriesta *et al*., 2016). The quality of chicken eggs is greatly influenced by the feed given to the chickens. The nutrient content of the feed plays a crucial role in determining the chemical composition and nutritional value of eggs, therefore, proper feed selection and formulation are key to improving chicken egg quality (Fadillah, 2022).

Mirah chickens are a superior local chicken breed originating from Simalungun Regency, North Sumatra (Siagian *et al*., 2013). Mirah chickens are native chickens and have not undergone extensive selection, although they are currently used specifically for certain events in Simalungun ethnic customs as a source of meat (Damanik and Sinaga, 2023; Silalahi *et al*., 2025). To increase the attractiveness of Mirah chickens, egg production must be improved, both in quality and quantity. However, many farmers still face challenges in increasing the nutritional value of eggs, particularly regarding essential fatty acid content.

Feed is one of the biggest components of total costs in poultry farming, accounting for 64-76% (Dewanti and Sihombing, 2012; Wiranata, 2024). Providing additional feed or feed additives is one effort to increase livestock productivity. The utilization of cricket flour in feed is an effort to improve livestock performance. Crickets (*Gryllus* sp) are one of the insects that are easy to cultivate and have quite potential. Cricket flour (*Gryllus* sp) contains saturated and unsaturated fatty acids (Herliatika *et al*., 2021). Previous research has shown that protein-rich feed can positively affect egg quality. According to Oriesta *et al*. (2016), feed containing high protein can increase egg weight and shell and albumen quality. Crickets also comprise of omega 3, 6, and 9 fatty acids which are good for cell growth (Setyawati and Magfirah, 2024). The fatty acid composition of eggs is greatly influenced by the chicken feed, chicken breed, and rearing system. Cricket flour contains high unsaturated fats, such as linoleic acid, linolenic acid, DHA, and EPA, and only contains small amounts of stearic acid. Research shows that modifying chicken feed, such as the addition of fish oil, flaxseed, or chia seeds, can improve the composition of polyunsaturated fatty acids (Fraeye *et al*., 2012). This suggests that improving feed quality can directly impact egg quality. Some people already consume fried crickets or foods containing cricket flour, but in limited quantities. Using crickets as chicken feed will improve egg quality, and consumers will benefit from the nutritional benefits of the crickets, which are passed on to the eggs.

Therefore, formulating feed based on natural sources, such as cricket flour, is crucial for improving the egg quality of local chickens. Based on this background, this study aimed to analyze the effect of adding cricket flour to feed on the fatty acid content of Mirah chicken eggs. It is hoped that the results of this study will contribute to the development of chicken and cricket farming in Indonesia and improve the quality of eggs produced.

Materials and methods

Animal maintenance

Hens were raised in accordance with Good Farming Practice guidelines no 31/Permentan/OT.140/2/2014 issued by the Ministry of Agriculture of the Republic of Indonesia. The hens used were 32 female Mirah chickens, aged 8 months. The feed used was commercial layer feed PC-05 (PT. Mabar Indonesia®) with the following nutritional content: Moisture 13%, Protein 23%, Fat 5%, Fiber 5%, Ash 7%, Calcium 0.9%, and Phosphorus 0.6%. The Mirah chickens were fed twice daily according to their needs: 50 grams per chicken at 8:00 AM and 50 grams per chicken at 4:00 PM. Observations were conducted for 21 days.

Eggs were collected daily after the chickens began laying. Egg samples were collected on the 15^{th} and 16^{th} days after the chickens were fed the treatment feed. Forty egg samples were taken, and each egg weighed 35-40 grams. The eggs used as laboratory test samples were taken from 32 Mirah chickens for laboratory testing.

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The cricket flour used was purchased online and is made from fresh crickets that are dried and ground into a flour for feed. Cricket flour contains 12.45% crude fat, 55.96% crude protein, and 7.94% crude fiber. The cages used in the study were battery cages with partitions for each chicken. The cages measured 35 cm long, 30 cm wide, and 35 cm high. Each partition housed one chicken, along with a feeder and a nipple holder.

Experimental design

This study was conducted using a Completely Randomized Design (CRD) consisting of four treatments. Each treatment was replicated four times, with two Mirah chickens per replicate. The four treatments used were:
P0= 100% commercial feed
P1= 96% commercial feed + 4% cricket meal
P2= 92% commercial feed + 8% cricket meal
P3= 88% commercial feed + 12% cricket meal

The parameters of this study were Feed Consumption (g) was measured by the amount of ration given minus the amount of remaining ration. The Strearic Acid Content was measured by weight of stearic acid divided total fat weight multiplied with 100%. Elaidic Acid Content was measured by the weight of elaidic acid: divided to the total fat weight and then multiplied x 100%. the Linoleic Acid was measured by the weight of linoleic acid divided to the total fat weight and then multiplied to 100%. the oleic acid was measured by the weight of linoleic acid divided to the total fat weight multiplied to 100%.

Data analysis

The data were analyzed using analysis of variance (ANOVA) and the real differences between treatments were tested using the Duncan test (DMRC) using SPSS software.

Results

Feed consumption

The average daily feed consumption results from the study of adding cricket flour (*Gryllus* sp.) to the ration is shown in Table 1 below.

Table 1 shows that the average feed consumption during the study was 76.68 g/head/day with a range of 69.96-82.36 g/head/day. The highest average was obtained at P2 78.26 g/head/day, while the lowest was obtained at P0 74.38 g/head/day. This indicates that the ration formulation with a mixture of cricket flour is still acceptable to Mirah chickens without affecting their appetite.

Table 1. Average daily consumption (grams/head/day).

Treatment	Repetition				Mean±SD
	1	2	3	4	
P0	74.96	71.93	80.64	69.96	74.38^{ns}±4.66
P1	71.04	80.04	77.96	82.36	77.85^{ns}±4.88
P2	80.43	76.61	77.61	78.39	78.26^{ns}±1.62
P3	81	76.5	70.54	76.93	76.24^{ns}±4.31

Note: The same superscript in the same column indicates not significant (P>0.05)

Stearic acid

The percentage stearic acid content of Mirah chicken eggs in a study of the addition of cricket meal (*Gryllus* sp.) to the ration is provided in Table 2.

The results showed that the stearic acid content in Mirah chicken eggs was highest in treatment P0 at 8.37%, and P1 showed a lower value at 3.98%. The significant decrease (P<0.05) in stearic acid levels in treatment P1 demonstrates the effect of adding 4% cricket flour to the ration on the saturated fatty acid composition of chicken eggs. This could be because the stearic acid content in replicates 3 and 4 was very low compared to replicates in P1 or other treatments. This could have been due to measurement errors or sample handling errors, but the fatty acid measurements were conducted in an accredited laboratory.

Table 2. Percentage of stearic acid (%) in Mirah chicken eggs.

Treatment	Repetition *				Mean±SD
	1	2	3	4	
P0	8.1	8.84	8.34	8.18	8.37^{a}±0.33
P1	6.93	6.78	1.29	0.93	3.98^{b}±3.32
P2	7.11	6.72	7.99	7.59	7.35^{a}±0.55
P3	7.36	7.51	9.2	6.08	7.54^{a}±1.28

Description: Different superscripts in the same column indicate significant differences (P<0.05): * Integrated Laboratory of PAU IPB. 2025

Elaidic acid

The percentage elaidic acid content of Mirah chicken eggs in a study involving the addition of cricket meal (*Gryllus* sp.) in the ration can be seen in Table 3. The results of this study indicate that the elaidic acid content in Mirah chicken eggs was highest in treatment P0 at 0.22%, and P3 showed a lower value at 0.13%. This decrease indicates that adding cricket flour to chicken rations can reduce the trans fatty acid content in the resulting eggs.

Table 3. Percentage of Elaidic acid (%) in Mirah chicken eggs.

Treatment	Repetition *				Mean±SD
	1	2	3	4	
P0	0.18	0.65	0.12	1.5	0.61^{ns}±0.64
P1	3.32	2.63	0.23	0.17	1.59^{ns}±1.63
P2	3.35	9.32	1.23	10.37	6.07^{ns}±4.47
P3	2.52	4	5	16	6.88^{ns}±6.16

Description: Different superscripts in the same column indicate significant differences (P<0.05): * Integrated Laboratory of PAU IPB. 2025

Linoleic acid

The percentage linoleic acid content of Mirah chicken eggs in this experiment can be seen in Table 4. The linoleic acid content in Mirah chicken eggs in this study indicates that the addition of cricket flour to the ration increased linoleic acid levels. Based on the analysis, the highest linoleic acid levels were found in P3 (6.88%) and the lowest in P0 (0.61%). Although the difference in the average linoleic acid content between treatments was very large, the ANOVA test results showed no significant difference (P>0.05). This occurred because the variation within the treatments was very large. Nevertheless, these results indicate the increase of linoleic acid levels is in line with the increasing levels of cricket flour in the ration, proving that crickets are an effective source of essential fats for improving the nutritional quality of chicken eggs.

Table 4. Percentage of Linoleic acid (%) in Mirah chicken eggs.

Treatment	Repetition *				Mean±SD
	1	2	3	4	
P0	0.18	0.65	0.12	1.5	0.61^{ns}±0.64
P1	3.32	2.63	0.23	0.17	1.59^{ns}±1.63
P2	3.35	9.32	1.23	10.37	6.07^{ns}±4.47
P3	2.52	4	5	16	6.88^{ns}±6.16

Description: Different superscripts in the same column indicate significant differences (P<0.05): * Integrated Laboratory of PAU IPB. 2025

Oleic acid

The percentage oleic acid content of Mirah chicken eggs in the study of adding cricket flour (*Gryllus* sp.) to the ration can be seen in Table 5. The oleic acid content (%) in Mirah chicken eggs in this study increased with the increase in cricket (*Gryllus* sp.) flour content in the ration. The highest average value was found in treatment P2 at 29.16%, while the lowest average was found in treatment P0 at 16.51%. In general, the increase in oleic acid levels in eggs was consistent with the increase in the percentage of cricket flour in the chicken ration.

Table 5. Percentage of Oleic acid (%) in Mirah chicken eggs.

Treatment	Repetition *				Mean±SD
	1	2	3	4	
P0	14.42	16.7	13.34	21.56	16.51^{ns}±5.38
P1	26.43	26.74	14.45	17.65	21.32^{ns}±7.74
P2	27.78	33.04	18.95	36.85	29.16^{ns}±8.38
P3	22.32	29.87	13.08	35.3	25.14^{ns}±9.64

Description: Different superscripts in the same column indicate significant differences (P<0.05): * Integrated Laboratory of PAU IPB. 2025

Discussion

This study is in line with Romadhon (2017) study which stated that the use of cricket flour as animal feed in chickens did not show a significant difference in feed consumption, with an average of 75,9 grams/head/day. Wang *et al*. (2004) said that cricket flour contains high excellent crude protein (58,3%), making it a potential source of nutrition that can be accepted by livestock without reducing feed intake. This nutritional ingredient significantly supports the chickens' metabolism and energy needs, thus maintaining optimal feed consumption. The average feed consumption during this study was 76.68 g/head/day, lower than the results of Wahju (2014), which found that the feed consumption of laying hens fed with cricket flour ranged from 80.00 grams/head/day. The influencing factor to the low daily feed consumption in this study was the use of Mirah chickens, which are local chickens with different physiological characteristics, metabolism, and feed consumption behavior than commercial laying hens.

According to Anggorodi (1979), the texture and physical density of the ration play a significant role in increasing palatability of ration. The rearing environment also contributes to feed consumption, particularly the temperature of the henhouse. High or fluctuating temperatures can reduce the chickens' appetite due to disturbance of the body's thermal balance. And the results of this study are higher than the results of Hamdan's study (2020) which stated that the feed consumption was 70.15 grams/head/day in laying hens fed a 10% mixture of cricket flour in the feed. This is likely due to an unbalanced feed formulation and high levels of crude fiber. Wahju (2014) said that the consumption of laying hen rations is highly dependent on the nutritional compound of the feed, especially energy and protein, as well as the balance of crude fiber.

The level of steric acid is lower than that reported by Calder and Grimble (2002), which found that stearic acid levels in eggs from laying hens fed a conventional ration without additional supplements were around 8.85%. This suggests that feed containing animal product or unsaturated fats, such as cricket flour, can reduce stearic acid levels. The results of this experiment showed that the average of stearic acid is 6.81%, in line with the results of Meyer *et al*. (2003) which was 6.80% stearic acid in chicken eggs supplemented with omega-3 from fish oil. The finding of this study are lower than the results by Rodriguez *et al*. (2005) which also showed that increased PUFA consumption causes a redistribution of fat metabolism, which leads to a decrease in saturated fatty acid levels such as stearic acid. The stearic acid level in eggs treated with flaxseed oil was 7.10%. Cricket flour has a relatively lower fat content than fat sources such as flaxseed oil or fish oil and has a more balanced fatty acid profile between saturated and unsaturated fatty acids. In addition, cricket flour is also rich in choline and high-quality animal protein, which supports growth without providing strong stimulation of drastic changes in lipid metabolism in the chicken's body (Belluco *et al*., 2013; Makkar *et al*., 2014). Meyer *et al*. (2003) stated that changes in the fatty acid composition of eggs are significantly influenced by the type of fat in the feed. They found that eggs from hens fed non-traditional vegetable and animal fat sources had lower stearic acid content than those fed commercial feed Wang *et al*., (2004) stated that cricket flour contains high levels of unsaturated fatty acids and is very low in trans fatty acids, including elaidic acid. The PUFA content, such as linoleic acid, linolenic acid, EPA, and DHA, helps shift fat metabolism toward healthy fatty acid synthesis.

The average of elaidic acid (0.16%) within this study is lower than the 0.35% found in chicken eggs from farms fed conventional feed (high in omega-6, low in omega-3) (Mozaffarian and Wu, 2011). This finding is lower than the study by Innes *et al.* (2002), which found that the use of hydrogenated oil in poultry feed increased elaidic acid levels to 0.31%. This demonstrates that natural fat sources, such as cricket flour, are safer than industrially produced fats.

The average elaidic acid content of 0.16% is lower than the 0.23% found in conventional corn-soybean-based feed (Meyer *et al*., 2003). This confirms that standard rations without the addition of cricket flour contain higher levels of elaidic acid. Simopoulos (2002) emphasized that a balance of omega-6 and omega-3 fatty acids and a low trans fatty acid content in feed will contribute to a healthier fat profile in animal products, such as eggs. This suggests that the use of cricket flour as an alternative feed is highly relevant for improving the nutritional quality of chicken eggs, particularly in reducing the content of harmful trans fatty acids.

Wang *et al*. (2004) stated in his research that linoleic acid is the dominant fatty acid in crickets and plays an important role in the formation of body tissue and the immune function of chickens. This confirms that the use of crickets as a supplementary feed has a positive impact on increasing levels of this fatty acid. The average of linoleic acid 3.79% of this study is higher than the 0.75% found in chicken eggs fed with ration which deficient in PUFA (Sergeant *et al*., 2016). Similarly, this finding is higher than Calder and Grimble (2002), who reported that omega-3 dominance in poultry feed results in a linoleic acid content of 2% due to metabolic competition between omega-3 and omega-6 within the chicken's body. This finding is lower than that of Meyer *et al*. (2003), who reported that linoleic acid levels in chicken eggs fed a corn oil-based feed reached 10.20%. This suggests that certain vegetable oils have a high omega-6 content and can be used as a source of linoleic acid.

Wang *et al*. (2004) reported that cricket flour has a linoleic acid content of 9.41%, making it a highly potential natural source of omega-6 in poultry feed. The results of this study are lower than those of Rodriguez *et al*. (2005) who reported that the linoleic acid content in eggs from chickens fed flaxseed oil and soybean oil reached 7.90%. This result was obtained from a semi-commercial feed specially formulated to enrich fatty acids. Simopoulos (2002) stated that a balanced omega-6/omega-3 ratio in feed significantly influences lipid metabolism and egg quality. Cricket flour containing the two essential fatty acids mentioned above increases linoleic acid in chicken eggs compared to treatments without cricket flour.

The percentage of oleic acid are lower than those of Calder and Grimble (2002), which reported that the oleic acid content in eggs fed an olive oil-based feed could reach 32.50%. additionally, these results are lower than those of Meyer *et al*. (2003), which found an average oleic acid value of 31.20% in eggs fed unsaturated fats from fish oil and the results of this study are also lower than those of research (Simopoulos, 2002), which found that eggs from chickens raised on omega-9-rich feed had oleic acid levels of between 30 and 50%.

The reason for the lower oleic acid levels in this study is that the unsaturated fat source used, namely cricket flour, has a more complex and natural fat composition than pure oils such as olive oil or fish oil. Olive oil contains approximately 7.75% pure oleic acid, thus directly increasing the levels of this fatty acid in chicken eggs (Calder and Grimble, 2002). In contrast, cricket flour contains only 20–25% oleic acid of total fat (FAO, 2013), as its composition also includes saturated fat, PUFA (omega-3 and omega-6), and non-fat components such as protein and chitin, which can affect the efficiency of lipid metabolism. This study's results are higher than those of Mozaffarian and Wu (2011) which found oleic acid levels in chicken eggs fed a ration of only around 17.50%. This suggests that the type of fat in the feed significantly influences the fatty acid content of eggs.

Calder and Grimble (2002) also stated that consumption of animal fat tends to increase saturated fatty acids compared to oleic acid, making the use of vegetable or insect fat sources such as cricket flour a better alternative. The results of this study are higher than those of Oliveira *et al*. (2010), which found an average oleic acid content of 20.40% in untreated broiler eggs. Wang *et al*. (2004) also emphasized that crickets contain dominant fatty acids essential for the body, including linoleic and oleic acids, which play a role in maintaining cell membrane integrity and cardiovascular health. Simopoulos (2002) emphasized the importance of a balanced omega-6/omega-9 ratio in feed to produce nutritionally healthier eggs.

Conclusion

The addition of cricket meals (*Gryllus* sp.) in the ration up to 12% did not significantly ($P>0.05$) affect feed intake or unsaturated fatty acids, but significantly ($P<0.05$) affected saturated fatty acids (Stearic acid). The optimal level of cricket flour (*Gryllus* sp.) supplementation on fatty acid content in Mirah chicken eggs was 8%. To obtain more comprehensive results, further research is needed with a longer period and a larger sample size to determine the long-term effects on egg quality and quantity.

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Conflict of interest

The authors have no conflict of interest to declare.

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