AGRIWAR JOURNAL
MASTER OF AGRICULTURAL SCIENCE WARMADEWA UNIVERSITY
E-ISSN: 2808-1137, **P-ISSN**: 2808-1323
Vol. 5, **No.** 2, **Dec 2025**, **Page** 113-118
DOI: https://doi.org/10.22225/agriwar.5.2.2025.113-118

The Effect of Calcium Soap Supplementation in Feed on Histology of Native Chicken Meat

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Abstract
This study aims to examine the effects of adding calcium soap (CA-PFAD) to the diet on the histology of meat from native chickens aged 12 weeks. This research took place for 6 weeks at the Sesetan Farm barn, Faculty of Animal Husbandry, Udayana University, located on Jalan Raya Sesetan, Gang Markisa, Denpasar, Bali. The design used was a Completely Randomised Design (CRD) with four treatments and six replications, so there were 24 experimental units. Each experimental unit used 3 chickens aged 6 weeks with a body weight of 662.85 ± 21.02 g. The four treatments were levels of calcium soap in ratios of 0%, 2%, 4%, and 6% respectively, for treatments A, B, C, and D. Variables observed included: histology of meat. The results of the study showed that the addition of calcium soap had a significant effect (P<0.05) on epimysium, perimysium of Balitbangtan superior village chickens (KUB), and reduced fat levels in endomysium chest muscle connective tissue of KUB chicken. Based on the research results, it can be concluded that the addition of calcium soap in the ration at levels of 2% can increase the thickness of the epimysium and perimysium and reduce the thickness of the endomysium in KUB chickens. Based on the results of this study, it can be recommended to farmers and future researchers that adding 2% calcium soap to the feed can increase the thickness of the epimysium and perimysium of KUB chickens.

Keywords: *native chicken; calcium soap; histology of meat.*

1. Introduction

Kampung Unggul Balitbangtan (KUB) chickens, bred from local Indonesian chickens, perform better than ordinary native chickens, especially in terms of feed efficiency and meat quality [1]. Improvements in the nutritional quality of KUB chicken feed, particularly through the use of calcium soap (CA-PFAD) as a source of protected fat, can optimise productivity and carcass quality, especially breast muscle.

Calcium soap provides stable energy without disrupting digestion, allowing protein to be directed towards tissue growth. Chicken meat structure consists of muscle tissue and connective tissue (epimysium, perimysium, and endomysium), which affect meat texture and quality [2-3]. The energy availability from calcium soap is expected to increase muscle fiber growth and reduce excess collagen, improving intramuscular structure [4]. [5] The Central Bureau of Statistics (2025) recorded that Indonesia produces 45.58 million tons of palm oil. Palm oil waste is rich in energy or fat, and palm oil has a high digestibility value of 85.4%, which is equivalent to an energy supply of 8,030 Kcal/kg. The processing of palm oil into cooking oil results in a byproduct called Palm Fatty Acid Distillate (PFAD). PFAD contains minerals such as calcium (Ca) and vitamin E. Calcium minerals affect bone growth and metabolic processes. [6] Stated that calcium is essential in metabolic processes. Vitamin E in PFAD can act as an antioxidant. [7] Stated that vitamin E influences the reduction of lipid oxidation in meat and animal adipose tissue. Controlling lipid oxidation in meat can help maintain meat quality. According to [8], tocotrienol can increase the height of villi and the depth of crypts in the small intestine, which means increasing the intestinal surface area and expanding the absorption field, thereby improving nutrient absorption capacity and optimizing intestinal histology.

This shows the potential of calcium soap in improving meat texture quality, making studies on its effect on the breast muscle tissue of KUB chickens very important for optimizing the nutrition of local poultry [9]. Based on the above description, this study needs to be conducted to examine the effect of calcium soap administration in feed on the histology of KUB chicken meat.

2. Materials and Methods

This study was conducted over a period of six weeks at the Sesetan Farm, Faculty of Animal Husbandry, Udayana University, located on Jalan Raya Sesetan, Gang Markisa, Denpasar, Bali. The histological analysis of the meat was carried out at the Denpasar Veterinary Laboratory.

The chickens used in this study were 6-week-old male KUB chickens weighing 662.85 ± 21.02 g, totalling 72 chickens. The KUB chickens were obtained from a chicken farm located in Abiansemal Village, Abiansemal District, Badung Regency.

This study used commercial feed 511B from PT Charoen Pokphand and calcium soap. Drinking water provided during the study was sourced from a borehole and given ad libitum. The composition of feed ingredients and nutritional content of feed 511B are presented in Tables 1 and 2.

Table 1. Composition of feed for 6-12 week old male KUB chickens

Feed Composition (%)	Level (%) of Ca-PFAD addition in commercial rations[1])			
	Treatment			
	A	B	C	D
Commercial Rations 511B	100	98,04	96,15	94,34
Calcium Soap	0	1,96	3,85	5,66
TOTAL	100	100	100	100

Description:
1. Treatment, consisting of:
A: KUB chickens fed commercial feed without calcium soap.
B: KUB chickens fed commercial feed with 2% calcium soap.
C: KUB chickens fed commercial feed with 4% calcium soap.
D: KUB chickens fed commercial feed with 6% calcium soap.

Table 2. Nutrient composition in the 511B feed ration for age 6–12 week Balitbangtan superior native chickens (KUB)

Chemical Composition	Treatment[2)]				Standard[1)] SNI – 8173.1- 2018
	A	B	C	D	
Metabolic Energy (kcal/kg)	2900	2946	2990	3032	2900
	20	19,62	19,26	18,91	18 – 22
Crude Protein (%)	5	5,51	6,01	5,94	5
Crude Fat (%)	13	12,88	12,78	12,68	13
Moisture Content (%)	0,90	0.94	0,98	1,02	0,80 – 1,10

Description:
1. SNI-8173.1-2015 Broiler chicken feed for fattening and native chicken feed.
2. Treatment, consisting of:
A: KUB chickens given commercial feed without calcium soap
B: KUB chickens fed commercial feed with 2% calcium soap.
C: KUB chickens fed commercial feed with 4% calcium soap.
D: KUB chickens fed commercial feed with 6% calcium soap.

Calcium soap

The calcium soap used in the feed mixture in this study was calcium soap made from palm oil waste in the form of solid lumps like limestone. The calcium oil solids were then ground into a

DOI: https://doi.org/10.22225/agriwar.5.2.2025.113-118

powder so that they could be easily mixed into the feed. The calcium soap was obtained from the Faculty of Mathematics and Natural Sciences, Department of Chemical Engineering, IPB. The nutritional content of calcium soap is presented in Table 3.

Table 3. Nutritional Content of Calcium Soap

Nutrients	Contents (%)
Water	7,5
BETN	54,24
TDN	97,32
Gross Energy kcal/kg	6562
Dry basis	
Ash	18,6
Protein	0,8
Crude Fat	31,3
Calcium	3,0

Source: [10].

Statistical analysis

The data obtained in this study were analyzed using analysis of variance. If there were significant differences between treatments ($P<0.05$), the analysis was continued with Duncan's multiple range test [11].

3. Results and Discussion

The results of research on age 12 week KUB chickens showed that the epimysium, perimysium, and endomysium connective tissues in the histology of meat fed a diet without added calcium soap (CA-PFAD) obtained smaller results compared to chickens fed added calcium soap (Table 3), but were statistically significantly different ($P<0.05$) compared to treatment A.

Table 4. Effect of calcium soap supplementation in feed on the histology of KUB chicken meat.

Variable	Treatment[1)]				SEM[3)]
	A	B	C	D	
Epimysium (µm)	80,38[a2)]	122,48[b]	125,24[b]	134,44[c]	0,95
Perimysium (µm)	35,37[a]	44,08[b]	48,96[c]	67,69[d]	0,97
Endomysium (µm)	15,20[a]	14,98[b]	22,12[c]	18,94[c]	0,70

Description:

1. Treatment, consisting of:
   A: KUB chickens fed commercial feed without calcium soap.
   B: KUB chickens fed commercial feed with 2% calcium soap.
   C: KUB chickens fed commercial feed with 4% calcium soap.
   D: KUB chickens fed commercial feed with 6% calcium soap.
2. Values with different letters in the same row indicate significant differences ($P<0.05$).
3. Standard Error of the Treatment Mean.

The results of research on age 12 week KUB chickens showed that the epimysium, perimysium, and endomysium connective tissues in the histology of meat fed a diet without added calcium soap (CA-PFAD) obtained smaller results compared to chickens fed added calcium soap (Table 3) but were statistically significantly different ($P<0.05$) compared to treatment A.

Chickens fed a diet with 2% calcium soap showed the most optimal histological results, with increased muscle thickness compared to the other treatments. This increased thickness of the

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epimysium directly affects the structure of the chicken breast muscle (pectoralis major). The epimysium is connective tissue that envelops the entire muscle and connects muscle fascicles, so a thicker epimysium provides stronger structural support to the breast muscle [4]. This causes the muscle fibres to be more tightly packed, increasing the compactness and elasticity of the muscle [4]. In chicken breast muscles, which are the primary muscles for wing movement, an increase in epimysium thickness can also improve the mechanical integrity of the muscle, making the meat denser yet still elastic when consumed [12-13].

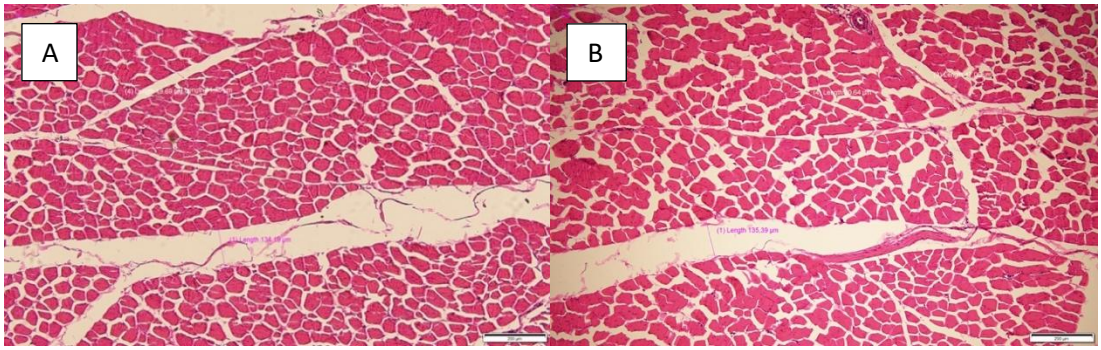
According to [14], Palm oil contains 50% saturated fatty acids, 40% monounsaturated fatty acids, and 10% polyunsaturated fatty acids, as well as small amounts of beta-carotene, tocopherols, and tocotrienols, all of which are natural antioxidants. Natural antioxidants and polyunsaturated fatty acids can reduce the growth of pathogenic bacteria, reduce intestinal mucosa inflammation, and improve nutrient absorption, thereby increasing nutrient absorption from meat [15]. The ability to digest and absorb nutrients is influenced by meat histology.

The longer the diameter of the epimysium, perimysium, and endomysium [12], the more effective the absorption of nutrients through the intestinal epithelium. It is also mentioned that an increase in the diameter of the epimysium and perimysium in chicken meat is closely related to improved digestive function and an increase in the surface area for nutrient absorption in the muscle tissue of chicken breast meat [16-17].

The epithelial cells of the chicken digestive tract are located in the intestines to provide maximum mucosal surface area for nutrient absorption. These nutrients are carried by blood vessels (connective tissue) located beneath the epithelium, then enter other tissues, including muscle (meat) [18]. The epithelial tissue functions to line (skin) or absorb/secrete (intestines), while muscle (meat) is the tissue that utilizes the nutrients that have been absorbed and transported for contraction [19]. Therefore, nutrient absorption and absorption efficiency depend on the integrity of the intestinal mucosa. Overall, the longer diameter of the epimysium, perimysium, and endomysium provides a larger mucosal surface area [16],[20].

The results of this study indicate that adding calcium soap to the feed can be an effective strategy for improving the quality of native chicken meat, providing benefits for farmers, the food industry, and becoming a subject for further research.

The image below shows that treatment A (without the addition of calcium soap) produced a smaller thickness than treatment B (addition of 2% calcium soap).



Description: microscope photo with 200x magnification, a) Chest muscle connective tissue without calcium soap addition, b) Chest muscle connective tissue with 2% calcium soap addition.

Figure 1. Histological comparison of treatment A and B meat measured in terms of epimysium, perimysium, and endomysium thickness.

4. Conclusion

Research on "The Effect of Calcium Soap Supplementation in Feed on Histology of Native Chicken Meat" provides important insights for future farming practices. The findings show that adding calcium soap to feed can significantly improve the histological quality of KUB chicken meat. 2% calcium soap dosage is optimal, offering farmers opportunities to improve chicken meat

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yield and quality. These results also pave the way for further research, including long-term effects and testing of other feed variations that may be beneficial. By applying these findings, there is hope of improving efficiency and productivity in poultry farming and supporting high-quality meat production. Based on the results of this study, it can be recommended to future farmers and researchers that adding 2% calcium soap to feed can increase the thickness of the epimysium and perimysium in KUB chickens, thereby improving meat quality.

Acknowledgments

The authors would like to thank the Faculty of Animal Husbandry, Udayana University, for their excellent care of the experimental chickens and for all assistance provided during the 2023 experiment.

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