**Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan**
**ISSN 2303-2227 eISSN 2615-594X**
**Accredited by National Journal Accreditation No. 105/E/KPT/2022**

**Vol. 12 No. 2 Juni 2024, Hlm: 101-104**
DOI: https://doi.org/10.29244/jipthp.12.2.101-104
Available online at https://journal.ipb.ac.id/index.php/ipthp/index

# Evaluation of Acid Value, Free Fatty Acids, and Malondialdehyde (MDA) Content in Chevon Fat: A Pre- and Post-Roasting Comparison

**M. S. Soenarno[1*], M. Arifin[1], S. Prabowo[1], Salundik[1], D. Murtini[1], Q. Alifiya[1], & R. R. S. Wihansah[2]**
[1]Department of Animal Production and Technology, Faculty of Animal Science, IPB University
Jl. Agatis, Kampus IPB Darmaga Bogor 16680, Indonesia
[2]Animal Health Study Program, Agricultural Development Polytechnic Bogor.
Jl. Snakma, Desa Pasir Buncir, Kecamatan Caringin, Kabupaten Bogor, 16730
*Corresponding author: msriduresta@apps.ipb.ac.id
*(Received 28-04-2024; Revised 19-05-2024; Accepted 20-06-2024)*

## ABSTRACT

**The roasting process using high heat will decrease the quality of fat and can produce toxic compounds that are mutagenic and carcinogenic to the body if consumed over a long period of time. This study aims to analyze the effect of roasting on chevon fat. The roasting process in this study was carried out using charcoal with a distance of 5 cm between the charcoal and the fat for 10 minutes. The observed test parameters were acid value, free fatty acids, and malondialdehyde (MDA) levels. The data obtained from the study were analyzed using a T-test based on the treatment of chevon fat before and after roasting. The results showed that the acid value and free fatty acid value of the fat after roasting were significantly (P<0.05) higher than before roasting, while the MDA value was not significantly different (P>0.05). This study indicates a change in the quality of chevon fat after roasting.**

**Keywords: acid number value, chevon fat, free fatty acid value, malondialdehyde**

## ABSTRAK

**Proses pemanggangan menggunakan panas tinggi akan menurunkan kualitas lemak dan dapat menghasilkan senyawa toksik yang bersifat mutagenik dan karsinogenik bagi tubuh jika dikonsumsi dalam jangka waktu panjang. Penelitian ini bertujuan menganalisis pengaruh pemanggangan terhadap lemak kambing. Proses pemanggangan dalam penelitian ini dilakukan menggunakan arang dengan jarak antara arang dengan lemak 5 cm selama 10 menit. Paramater uji yang diamati yaitu nilai bilangan asam, asam lemak bebas dan kadar Malondialdehyde (MDA). Data hasil penelitian yang diperoleh dianalisis menggunakan uji T berdasarkan perlakuan lemak kambing sebelum dan setelah pemanggangan. Hasil yang diperoleh menunjukkan bahwa nilai bilangan asam dan nilai asam lemak bebas lemak setelah dipanggang secara signifikan (P<0.05) lebih tinggi dari sebelum dipanggang sedangkan untuk nilai MDA tidak berbeda nyata (P>0.05). Penelitian ini menunjukkan adanya perubahan kualitas lemak kambing setelah dilakukan pemanggangan.**

**Kata kunci: lemak kambing, malonaldehida, nilai bilangan asam, nilai asam lemak bebas**

## INTRODUCTION

Renowned for its potential to boost stamina and vitality, chevon (goat meat) is widespread popularity, particularly in the form of chevon satay. The process of making satay involves roasting. A typical chevon skewer consists of a mixture of chevon and fat. Pieces of chevon and fat are skewered and grilled over coals from wood charcoal or coconut shells at a specific distance. Using a hand fan, roasting is usually done manually (Adiyastiti *et al*. 2014).

The high temperatures used in satay processing cause damage to the fat contained in the satay. The extent of fat damage is influenced by both temperature and processing time. Higher temperatures result in more intense fat degradation (Mustapha *et al*. 2019). Oxidation and hydrolysis of fat contribute to the decline in fat quality, which can be assessed through the values of acid number, free fatty acids, and malondialdehyde (MDA) (Amaral *et al*. 2018)

The acid number indicates the amount of free fatty acids in the oil, expressed as mg of base per gram. It is a crucial parameter in determining oil quality. This number reflects the free fatty acids in the oil resulting from hydrolysis reactions, particularly during processing (Abril *et al.* 2023). Free fatty acids are fatty acids that exist as free acids, not bound as triglycerides. They are produced through hydrolysis and oxidation processes and typically combine with neutral fats. Free fatty acids serve as an indicator of fat freshness.

While enhancing flavor, roasting methods involving high heat can also form mutagenic and carcinogenic toxic compounds if consumed over long periods (Saputro 2020). Among these toxic compounds is MDA, an end product of lipid peroxidation formed after the action of radical compounds. MDA is used to indicate free radical presence in the body and oxidative damage to cell membranes (D'andrea *et al*. 2022) Elevated levels of malondialdehyde (MDA) are correlated with cancer progression and may signal an increased risk of cancer due to oxidative stress. As a byproduct of lipid peroxidation, MDA acts as an indicator of oxidative damage to cell membranes, a condition that is associated with the development of cancer (Lepara *et al.* 2020). The benefits or urgency of this research can be added to the literacy of a more appropriate processing in terms of nutrition, food safety or health. For example, high MDA can cause cancer, so it is hoped that the results of this research can be an evaluation novelty in the correct roasting processing.

## MATERIAL AND METHODS

### Methods

**Fat Roasting.** The beef fat was washed until clean and subsequently cut into 3x3cm pieces. It was then roasted over hot coals for 6 minutes, with each minute seeing it turned over and rotated to the other side of the grill. Following the roasting process, the sample was cooled and prepared for analysis.

**Acid Number Analysis (AOAC 2005).** A total of 7.05 g of sample was weighed and crushed, then placed into a 250 mL Erlenmeyer flask and homogenized with 50 mL of neutral alcohol solution. Subsequently, the sample was titrated with 0.25 M NaOH solution until it turned pink. The acid number was calculated using the formula:

$$\text{Free fatty acid (as oleic)} = \frac{282.46\ x\ 0.25\ x\ mL\ NaOH}{Sample\ Weight\ (g)} \times 100\%$$

$$\text{Acid value} = \text{percentage of free fatty acids} \times 1.99$$

**Fatty Acid Analysis (AOAC 2005).** The sample was weighed, 5 g, and then placed into an Erlenmeyer flask. Subsequently, it was supplemented with 50 mL of 95% neutral alcohol. The sample underwent heating for 10 minutes while being stirred. After cooling, 3-5 drops of 1% PP indicator were added, and it was titrated with a standardized 0.1 N NaOH solution until the colour turned pink. The calculation of free fatty acids (%FFA) was performed using the formula:

$$\%\ FFA = \frac{mL\ NaOH\ \times M\ NaOH\ \times MM\ Fatty\ Acid\ (lauric\ acid)}{Sample\ Weight\ (g)\ \times 1000} \times 100\%$$

where % FFA = free fatty acid content; mL NaOH = volume titrant NaOH; M NaOH = molarity of the solution NaOH mol/L); MM = Fatty acid molar mass (palmitic acid) 256 g/mol.

**Analysis of Malondialdehyde (MDA) Level as Thiobarbituric Acid Reactive Substances (Sorensen *et al*. 1996).** A total of 10 g of sample was crushed and homogenized by mixing 50 mL of distilled water containing 0.1% propyl gallate (PG) and 0.1% ethylene diamine tetraacetate (EDTA), stirring until evenly distributed. The mixture was transferred into a distillation tube and washed by adding 47.5 mL of distilled water containing 0.1 PG and 0.1 EDTA. The mixture was acidified with 2.5 mL of HCL solution (HCL: water = 1:2), and five drops of antifoam A was added. The distillation process was carried out until 50 mL of distillate was collected for each sample. 5 mL of distillate was added with 5 mL of 0.02 M TBA solution in a glass tube and incubated in a water bath at 100 °C for 40 minutes before being cooled to room temperature and running water. The absorbance of the distillate sample was measured using a spectrophotometer at a wavelength (λ) of 532 nM. Next, the tube rack is removed and run through with water to cool. MDA levels were calculated systematically using the following formula.

$$Malondialdehyde\ (MDA) = \frac{CMDA\ X\ Vdes}{MS}$$

where:

$C_{MDA}$ : Concentration of MDA as read on the standard curve
$V_{des}$ : Volume of distillate (mL)
$M_S$ : Weight of sample (g)

**Experimental Design and Data Analysis (Steel and Torrie (1993).** The data in this study were analyzed using the T-test by comparing samples before and after roasting. The data obtained from this study namely acid value, free fatty acid, and MDA in chevon fat were analyzed using a T-test based on the treatment of chevon fat before and after roasting.

## RESULTS AND DISCUSSION

Roasting fat can affect the quality of the fat. Roasting can significantly impact the quality of fat due to various chemical reactions and transformations that occur during the cooking process. Roasting exposes fats to high temperatures, leading to lipid oxidation. This process involves the breakdown of fats into smaller molecules due to exposure to oxygen and heat. The effect of roasting chevon fat can be seen from the acid value, free fatty acid value and malonaldehyde content in Table 1. Based on the research results, Chevon fat post-roasting exhibited a significantly higher acid value ($P<0.05$) than its pre-roasting state. This phenomenon can be attributed to the oxidation process facilitated by oxygen during roasting, which is essential for sustaining ember combustion and generating heat. The heat and light during roasting stimulate fat oxidation, consequently elevating the acidity value of the roasted fat relative to its pre-roasted counterpart. A heightened acid number also signifies an increased level of free fatty acids resulting from fat hydrolysis or inadequate processing. Therefore, a higher acid number reflects lower fat quality (Ketaren 2002). Acid value helps assess the freshness and quality of meat products. Higher acid values can indicate increased levels of FFAs, which may result from lipid oxidation processes or microbial activity post-slaughter. This increase in FFAs can contribute to undesirable flavors and aromas in meat, affecting its sensory attributes and shelf life (Lee *et al.* 2016). Monitoring acid value in meat is crucial in the food industry to ensure product quality, safety, and compliance with regulatory standards.

Table 1. The values of acid number, free fatty acids, and MDA content in Chevon Fat.

| Parameter | Chevon Fat Pre-Roasting | Chevon Fat Post-Roasting |
|---|---|---|
| Acid Value (%) | 10.96±1.41b | 18.94±1.40a |
| % FFA | 0.18±0.06b | 0.52±0.09a |
| MDA (mg/kg) | 3.28±0.66 | 3.22±0.64 |

Note: Means in the same column/row with different superscript differ significantly ($P<0.05$).

Free fatty acids arise from fat hydrolysis, and their determination indicates oil quality (Winarno 2002). According to the test results, Chevon Fat's free fatty acid content exhibited a significantly different value post-roasting into satay than its pre-roasting state. This elevation is attributed to fat hydrolysis occurring during the roasting process. In this hydrolysis reaction, oil converts into free fatty acids and glycerol. Roasting involves exposing fats to high temperatures, which accelerates lipid oxidation. This process breaks down triglycerides (fat molecules) into free fatty acids (FFAs), which increases the FFA content in the fat. The increase in FFAs can be quantitatively measured by the acid value, which represents the amount of free fatty acids present in the fat. Free fatty acids (FFAs) in meat refer to fatty acids that are released from triglycerides (the primary form of fat in meat) due to enzymatic or chemical hydrolysis. When meat undergoes processing, storage, or cooking, triglycerides can break down into FFAs and glycerol. This process is influenced by factors such as temperature, pH, and the activity of enzymes and microorganisms. FFAs contribute to the sensory qualities of meat, affecting its flavor, aroma, and texture. In fresh meat, the amount of FFAs is relatively low, but it can increase over time due to lipid oxidation or microbial activity, leading to rancidity and off-flavors.

Malondialdehyde levels in Chevon fat, both before and after processing into satay, exhibited values that were not significantly different. This suggests the potential inhibitory activity of radical compounds formed from the spices utilized in satay processing. These spices, such as garlic, pepper, and coriander, are reported to possess antioxidant activity (Tanganakul *et al*. 2009). Elevated malondialdehyde levels indicate decreased fat quality, signifying oxidation of the fat in the product. The high malondialdehyde levels are attributed to the cooking process, which entails direct heat exposure to Chevon fat. Malondialdehyde (MDA) is a marker compound formed during lipid oxidation. It is a reactive aldehyde that forms when polyunsaturated fatty acids (PUFAs) are oxidized. Roasting, especially at high temperatures, promotes the formation of MDA and other lipid oxidation products. The level of MDA in fats can thus indicate the extent of oxidative damage during roasting.

The acid value, FFA, and MDA content are indicators of fat quality and stability. Higher acid values and elevated MDA levels typically indicate greater lipid oxidation and lower fat quality. Oxidized fats can develop off-flavors, off-odors, and potentially harmful compounds, impacting both sensory attributes and nutritional value. Roasting influences the acid value, MDA content, and FFA levels in fats primarily through the process of lipid oxidation. Understanding and controlling roasting conditions are essential for maintaining fat quality, minimizing the formation of harmful compounds, and ensuring the sensory and nutritional benefits of roasted chevon fats. Roasting chevon involves several considerations to ensure optimal nutrition, food safety, and health outcomes. Proper temperature control during roasting is crucial to achieve thorough cooking while preserving nutritional value. Overcooking chevon can lead to nutrient loss, especially heat-sensitive vitamins like B vitamins and vitamin C (Zhang *et al.* 2020). Handling chevon roasting according to research-based recommendations involves careful temperature control, avoidance of overcooking, marination for safety and flavor enhancement, and attention to minimizing harmful compound formation. These practices ensure that roasted chevon not only meets nutritional needs but also contributes positively to food safety and health outcomes.

## CONCLUSION

High heat exposure during the roasting process of chevon fat in chevon satay production can increase the acid value and free fatty acid levels but does not elevate the MDA content. Roasting influences lipid oxidation in chevon, affecting the formation of compounds free fatty acids (FFA), avid value and malondialdehyde (MDA) and proper cooking methods can minimize the production of oxidative by-products, thereby maintaining meat quality.

## REFERENCES

**Abril, B., R. Bou, J. V. García-Pérez, & J. Benedito.** 2023. Role of enzymatic reactions in meat processing and use of emerging technologies for process intensification. Foods. 12(10):1940. https://doi.org/10.3390/foods12101940

**Adiyastiti, B. E. T., S. Edi, & Rusman.** 2014. The effect of grilling time and fuel type on the sensory quality and benzo(a)pyrene levels of chevon satay. Buletin Peternakan. 38(3): 189-196

**Amaral, A. B., M. V. Silva, & A. C. Lannes.** 2018. Lipid oxidation in meat: mechanism and protective factors – a review. Food Sci. Tech. 38(1): 1-15.

**AOAC.** 2005. Official Methods of Analysis of the Association of Official Analytical Chemists. Agricultural Chemistry, Washington DC.

**Asni, E.** 2009. Pengaruh hipoksia berkelanjutan terhadap kadar malonaldehid, glutation tereduksi dan aktivitas katalase ginjal tikus. Majalah Kedokteran Indonesia. 59(12): 595-600.

**Astuti S, D. Muchtadi, M. Astawan, B. Purwantara, & T. Wresdiyanti**. 2008. Kadar peroksida lipid dan aktivitas superoksida dismutase (SOD) testis tikus yang diberi tepung kedelai kaya isoflavon, seng dan vitamin E. Majalah Kedokteran Bandung 40 (2). (In Press).

**Arguelo, N. N., E. R. M. Garcia, J. A. Ferreira de Lara, & A. L. J. Ferraz**. 2016. Physicochemical characteristics and lipid oxidation of chicken inner fillets subjected to different thermal processing types. Brazilian J. Poult. Sci. 18 (3):443-450.

**D'andrea, L., P. Napolitano, & A. G. D'Alessandro.** 2022. Free radical properties, source and targets, antioxidant consumption and health. Oxygen. 2(2):48-78.

**Ketaren, S.** 2002. Pengantar Teknologi Minyak dan Lemak Pangan Cetakan Pertama. Universitas Indonesia (UI)-Press, Jakarta. Washington DC. Washington DC.

**Lee, J. H., A. Jang, & M. Lee.** 2016. Effects of free fatty acid content and degree of lipid oxidation on the flavor of cooked beef. Meat Science. 112:18-24.

**Lepara, Z., O. Lepara, A. Fajkić, D. Rebić, J. Alić, & H. Spahović.** 2020. Serum malondialdehyde (MDA) level as a potential biomarker of cancer progression for patients with bladder cancer. Romanian Journal of Internal Medicine. 58(3):146-152.

**Mustapha, N. A., W. Z. Wan Ibadullah, & N. Saari.** 2019. Effects of storage time and temperature on lipid oxidation and protein co-oxidation of low-moisture shredded meat products. Antioxidants, 8(10):486.

**Rahardjani, K. B.** 2010. Hubungan antara malonaldehyde (MDA) dengan hasil luaran sepsis neonatorum. Sari Pediatri. 12 (2): 82-87.

**Saputro, E.** 2020. Telaah pustaka: heterocyclic aromatic amines (HAA), karsinogen pemicu kanker dalam olahan daging panggang/bakar/goreng. J. Kewidyaiswaraan. 5(1):36-47.

**Sorensen, G & S. Jorgensen.** 1996. A critical examination of some experimental variables in the 2-thiobarbituric acid (TBA) test for lipid oxidation in meat products. Z Lebensem Unters Forsch. 202:205-210.

**Steel, R. G. D. & J. H. Torrie**. 1993. Prinsip dan Prosedur Statistika. Terjemahan. Gramedia Pustaka Utama, Jakarta.

**Tangkanakul, P., P. Auttaviboonkul, B. Niyomwit, N. Lowvitoon, P. Charoenthamawat & G. Trakoontivakorn**. 2009. Antioxidant capacity, total phenolic content and nutritional composition of Asian foods after thermal processing. Intern. Food. Res. J. 16:571-580.

**Winarno, F. G.** 2002, Kimia Pangan dan Gizi. Gramedia Pustaka Utama, Jakarta.

**Zhang, H., Q. Xu, J. Yu, M. Gao, L. Zhang, Y. Li, & L. Zhao.** 2020. Effects of marination and roasting on the formation of heterocyclic amines in chicken breasts. Food Control. 109:106910.