International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 40 No. 2 September 2023, pp. 105-110

# *Fatty Acid as an Anti-inflammatory Component from Black Soldier Fly (Hermetia illucens) Prepupa Oil*

Salbella Dwi Utari, Resti Rahayu*, Putra santoso

Departement of Biology
Faculty of Mathematics and Natural Sciences
Padang, Indonesia
*restirahayu@sci.unand.ac.id



**Abstract— Inflammation is a serious health problem that requires treatment. One of the physical factors that cause inflammation is a wound. The use of topical antibiotics for wound healing continuously in the long term can cause many side effects and is not economical. Therefore, the use of natural materials that are effective and economical is needed. One of them is the prepupa black soldier fly. This study aimed to analyze the content of the black soldier fly prepupa compound and its potential as an anti-inflammatory. The results showed that there were 9 fatty acids in black soldier fly prepupae oil analyzed by GCMS namely lauric, myristic, palmitic, stearic, capric, palmitoleic, oleic, linoleic, and eicosapentaenoic. These fatty acids act as anti-inflammatory, analgesic, antipyretic, and antimicrobial. Therefore it is necessary to carry out further research in vivo to see the potential of prepupae oil fatty acids as an anti-inflammatory.**

**Keywords— Anti-Inflammatory, Black Soldier Fly, Fatty Acid, Prepupae.**

## I. INTRODUCTION

Inflammation is the response of the immune system to noxious stimuli, such as damaged cells, pathogens, toxic compounds, or radiation [1]. At the tissue level, inflammation is characterized by redness, swelling, heat, pain, and loss of tissue function, which results from local immune, vascular, and inflammatory cell responses to infection or injury [2]. One of the physical factors that cause inflammation is a wound. Wounds are anatomically damaged cells and the function of a tissue as a result of mechanical, chemical, heat, microbial, or immunological disturbances [3]. Wound healing occurs in five phases: inflammation, neovascularization, formation of granulation tissue, re-epithelialization and formation of new extracellular tissue matrix, and tissue remodeling [4]. The basis of wound healing is minimizing tissue damage, preventing infection, and providing adequate tissue perfusion and oxygenation, proper nutrition, and a moist wound-healing environment [5].

Wound healing can occur naturally where the body can deal with tissue damage itself but the healing rate is relatively slow and the probability of being infected with microbes is high. For this reason, efforts are needed to accelerate wound healing and reduce the risk of infection [6]. Many topical antibiotics have been used in the treatment of burns. One of them is Silver sulfadiazine which is a topical antimicrobial agent which has become the standard of care in the treatment of burns. However, topical application of silver sulfadiazine cream has been shown clinically to occasionally result in systemic complications such as neutropenia, skin flushing, crystalluria, and methemoglobinemia. These treatments can prevent wound repair and lead to scar tissue formation. Therefore, the formation of scar tissue after injury has become one of the most extensively studied problems for which researchers are continuously developing new applications through experimental and clinical trials [7].

As a result of the side effects of the continuous use of topical antibiotics, it triggers the exploration of safer and more effective natural medicinal ingredients. These natural-based medicines are generally derived from various kinds of plant oils. Plant products have proven to be effective in accelerating wound healing because they consist of various antioxidant and anti-inflammatory principles. Apart from plants, medicines made from nature can also be derived from animal oils, one of which is oil from the prepupae of the black soldier fly insect. Based on research [8] Black Soldier Fly prepupae contain amino acids, fatty acids, as well as vitamins and minerals. The dry matter content of amino acids in the prepupa ranges from 39.97% and the crude fatty acid content ranges from 50% [9]. Fatty acids have been shown to play a role in accelerating wound healing. So far, black soldier fly larvae have been used as bioconversion agents for organic waste and as a source of feed for animals. Scientific information about the efficacy of bioactive substances in black soldier fly prepupae especially as drugs is very limited. This study aimed to analyze the fatty acid content of black soldier fly prepupa oil and its potential as an anti-inflammatory.

## II. Research Method

### 2.1. Black Soldier Fly Prepupae Oil Extraction

Black Soldier Fly prepupae samples were obtained from black soldier fly breeders in West Sumatra, Indonesia, fed fermented tofu pulp. Wet prepupae were dried under the sun. The dried prepupae were then pulverized using a grinder. The extraction stage of black soldier fly prepupae uses hexane solvent at room temperature for 24 hours. After filtering using Whatmann no.1 filter paper, the extract was evaporated under low pressure using a rotary evaporator at 40°C and stored in a refrigerator at four 4°C until used.

### 2.2. Gas Chromatography-Mass Spectrometric (GC-MS) Analysis

GC-MS analysis of black soldier fly prepupae oil was performed using GCMS-QP2010 Plus. With a pressure of 31.5 kPa, with helium as the carrier gas used, helium flowed at a flow rate of 0.70 mL/min and a linear velocity of 30.5 cm/sec. injector temperature at 60ºC to 220ºC. The oil is injected with a volume of 0.5 µl. The eluted components will be detected on the mass detector. Spectra of known compound components will be stored in the NIST library.

## III. Result and Discussion

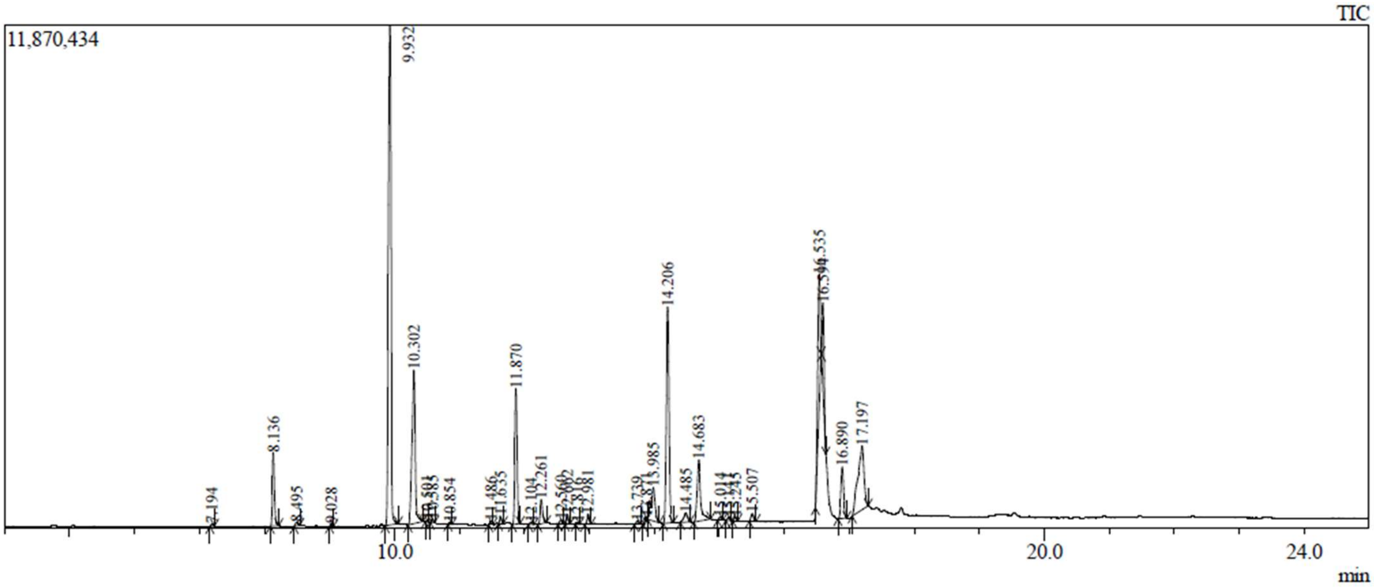


Fig. 1. Chromatogram Of Fatty Acid Analysis Of Black Soldier Fly Prepupa Oil

Based on the results of Gas chromatography-mass spectrometry analysis, there were 9 identified fatty acids in the black soldier fly prepupa oil. The fatty acid content consists of lauric, myristic, palmitate, stearate, capric acids which are Saturated Fatty Acids (SFA). Palmitoleic, oleic is a monounsaturated fatty acid (MUFA) and linoleate, eicosapentanoic is a Polyunsaturated Fatty Acid (PUFA) compound (Fig.1). The results of this study are by research [10] that the fatty acid content in the black soldier fly prepupae is capric acid, lauric acid, myristic acid, palmitate acid, stearic acid, palmitoleic acid, oleic acid, linoleic acid, linolenic, eicosapentaenoic and docosahexaenoic. The highest peak produced, namely at the retention time of 9.932, predicted that this compound was lauric acid, which was most abundant in black soldier fly prepupa oil.

Some of these fatty acids can influence the inflammatory process by inhibiting macrophages to produce NO (nitric oxide) and inhibiting the cyclooxygenase (COX2) pathway. Thus, the symptoms of inflammation can be reduced. This statement is supported by research [11] that extracts from snakehead fish oil contain omega-3 and omega-6 unsaturated fatty acids which are nutrients that can speed up the wound healing process. Saturated fatty acids can modulate cells or tissues and respond to infection, injury and inflammation. Fatty acids play a role in adding energy to the process of forming myelin sheaths and forming cell membranes in tissue growth in wound healing.

TABLE I. RESULTS OF BLACK SOLDIER FLY PREPUPA OIL FATTY ACID ANALYSIS

| **Fatty acids compound** | **Group** | **Area %** | **Heigh %** | **R.Time** |
|---|---|---|---|---|
| Lauric acid | Saturated Fatty Acid (SFA) | 33.75 | 37.85 | 9.932 |
| Myristic acid | Saturated Fatty Acid (SFA) | 6.67 | 9.05 | 11.486 |
| Palmitic acid | Saturated Fatty Acid (SFA) | 13.66 | 14.83 | 14.683 |
| Stearic acid | Saturated Fatty Acid (SFA) | 4.32 | 4.61 | 17.416 |
| Capric acid | Saturated Fatty Acid (SFA) | 0.17 | 0.2 | 8.495 |
| Palmitoleic acid | Monosaturated Fatty Acid (MUFA) | 3.23 | 3.64 | 13.930 |
| Oleic acid | Monosaturated Fatty Acid (MUFA) | 13.94 | 11.83 | 11.728 |
| Linoleic acid | Polyunsaturated Fatty Acid (PUFA) | 25.08 | 17.88 | 13.871 |
| eicosapentanoat | Polyunsaturated Fatty Acid (PUFA) | 0.08 | 0.11 | 12.104 |

According to [12], fatty acids have been shown to play a major role in the wound healing process. The fatty acid content of the black soldier fly prepupa is capric acid and lauric acid. Capric acid and lauric acid have antimicrobial and anti-inflammatory activity. This is supported by the opinion [13] that capric acid has antibacterial activity against several Gram-positive and Gram-negative bacteria, anti-fungal and antiviral activity. [14] reported that capric acid suppressed PGE2 production in lipopolysaccharide (LPS)-stimulated RAW264.7 macrophages. Capric acid has also been shown to inhibit inflammation-induced nitric oxide (NO) production and NO synthase (iNOS) gene expression in LPS-stimulated RAW264.7 macrophages [15]. In addition, [16] also reported that lauric acid showed activity as an antimicrobial and anti-inflammatory. Capric acid and lauric acid have a marked suppressive effect on IL-8 and IL-6 production. Further testing on signaling pathways showed that capric acid and lauric acid suppressed MAPK phosphorylation and NF-kB activation [17].

The content of other fatty acids in the black soldier fly prepupa is linolenic acid, linoleic, and oleic. Linolenic, linoleic and oleic acids are precursors for the synthesis of inflammatory or anti-inflammatory mediators and are part of the cell membrane structure of phospholipids, ceramides, and sebum, which are important components of the lipid barrier and are involved in regulating cell division and differentiation, angiogenesis and extracellular matrix synthesis [18]. This is supported by the statement [19] that linolenic, linoleic, and oleic acids are precursors to eicosapentaenoic acid (EPA), arachidonic acid (AA), and eicosatrienoic acid (ETA) which are part of the structure of cell membrane phospholipids and serve as substrates for the synthesis of eicosanoids (inflammatory mediators), such as prostaglandins, thromboxane, prostacyclin (via cyclooxygenase), and leukotrienes (via lipoproteins). oxygenase). Eicosanoids formed from arachidonic acid, prostaglandin E2, thromboxane B2, and leukotriene B4 are more potent proinflammatory inducers than those formed from EPA, prostaglandin E3, thromboxane B3, and leukotriene B5, which have anti-inflammatory effects. This family of fatty acids competes for the same enzymes. Where the fatty acids induce local inflammatory responses and compete with linoleic and linolenic acids to synthesize the same enzymes (cyclooxygenase and lipooxygenase). So that the inflammatory mediators formed by arachidonic acid are less strong so that inflammation does not occur [20].

Another fatty acid content in the black soldier fly prepupa is stearic acid. Stearic acid is a common nutritional long-chain fatty acid and is known as a potent anti-inflammatory lipid. Stearic acid plays a role in weakening induced inflammation by suppressing the recruitment/accumulation of inflammatory cells and/or NF-kB activity, if NFkB activation is inhibited it will inhibit the synthesis of IL-1 and TNFα. Inhibition of IL-1 and TNFα synthesis causes reduced stimulation of cell membrane phospholipids so that arachidonic acid is not released from cell membrane phospholipids by phospholipase activation. This situation causes reduced COX-2 protein synthesis and reduced prostaglandin biosynthesis so that the inflammatory response is reduced [21].

Another fatty acid content is palmitoleic acid. Palmitoleic acid is an omega-7 monounsaturated fatty acid. Palmitoleic acid is reported to have anti-inflammatory effects, palmitoleic acid plays a role in reducing the production of cytokines and adhesion molecules and reducing the expression of several pro-inflammatory genes (NFkB, MCP-1, IL-6, and COX-2) while at the same time regulating PPARα gene expression anti-inflammatory [22]. Based on research conducted that saturated palmitic acid (29% to 36%) and omega-7 unsaturated palmitoleic acid (36% to 48%), which are derived from Sea buckthorn pericarp oil can increase the epithelization of skin and mucosal tissue, besides that it has been shown to play a role in as an antioxidant, anti-inflammatory, and regenerative agent [23]. Other saturated fatty acids in the black soldier fly prepupa are myristic acid and palmitic acid. Myristic acid and palmitic acid are positively associated with inflammation [24]. This is different from the opinion [25] that the content of linoleic acid (50% to 59%), oleic (20% to 24%), and palmitic acid (11% to 13%) in cumin oil has anti-inflammatory, analgesic, antipyretic, antimicrobial, and antineoplastic. In addition, studies containing acids in triglycerides, namely linoleic (46%), palmitic (30%), oleic (11%), stearic (8%), and -linolenic acid (2%) show increased regulation of the production of growth factors, such as transforming growth factor beta 1 and granulocyte-macrophage colony-stimulating factor. In addition, iAQP-3 mRNA expression was increased, thereby improving skin hydration [26]. This can be interpreted that the content of fatty acids, namely myristic acid and palmitic acid act as anti-inflammatory with a low percentage. The content of other fatty acids in the black soldier fly prepupa is eicosapentaenoic and docosahexaenoic (Table 1). Eicosapentaenoic (EPA) and Docosahexaenoic (DHA) are omega-3 saturated fatty acids that play a role in inhibiting COX which causes reduced release of proinflammatory cytokines, such as TNF-α. The anti-inflammatory properties of EPA are partly due to peroxisome proliferator-activated receptor (PPAR)-mediated suppression of nuclear factor (NF)-κB activation. the anti-inflammatory effects of EPA depend on suppressing PPAR-γ-mediated NF-kB activation [27].

## IV. Conclusion

Based on the results of Gas chromatography-mass spectrometry (GCMS) analysis, 9 fatty acids were identified, namely lauric, myristic, palmitate, stearate, capric, palmitoleic, oleic, linoleate and eicosapentanoic acids which act as anti-inflammatory, analgesic, antipyretic and antimicrobial. Based on this research, in vivo research is needed to see the potential of prepupae oil fatty acids as anti-inflammatory.

## V. Acknowledgment

Thank you to Andalas University under the Research-Publication Indexed (R.P.T.) UNAND Scheme (Contract No. T/148/UN.16.17/PT.01.03/KO-RPT/2022. P.I.C. Dr. Resti Rahayu).

## References

[1]. M. Ruslan, “Inflammation 2010: new adventures of an old flame”, vol. 140. Cell, pp. 771–776, 2010.

[2]. T. Osamu, A. Shizuo, “ Pattern Recognition Receptors and Inflammation”, vol. 140. Cell, pp.140: 805–820, 2010.

[3]. T. Rupesh, N. Jain, R. Pathak, and S.S. Sandhu, “Practices in Wound Healing Studies of Plants”. Hindawi Publishing Corporation, pp. 1-17. 2011.

[4]. K. G. Nevin, T. Rajamohan, “Effect of topical application of virgin coconut oil on skin components and antioxidant status during dermal wound healing in young rats”, vol. 23, no. 6. Skin Pharmacology and Physiology, pp. 290–297. 2010.

[5]. G. F, Pierce, T. A, Mustoe, “Pharmacologic enhancement of wound healing”, vol. 46, no. 1. Annual Review of Medicine, 467–481. 1995.

[6]. S. Prafulla, B. Bhimani, C. Prajapati and V. Sabale, “An Overview of Medicinal Plants as Wound Healers”, vol. 2, no.11. Journal Application Pharmaceutical Science, pp. 143-150. 2012.

[7]. V. Giuseppe, Y. Lim, G. Belmonte, C. Miracco, L. Zanardi, V. Bocci and V. Travalgi, “Ozonated sesame oil enhances cutaneous wound healing in SKH1 mice”, vol. 19, no. 1. Wound Repair Regen., pp. 107–115. 2011.

[8]. M. Harinder, G. Tran, V. Heuze, P. Ankers, “State-of-the-art on use of insects as animal feed, vol. 197. Anim Pakan Sci Technol, pp. 1-33. 2014.

[9]. Rachmawati, “Development and Nutritional Content of Hermetia illucens (Linnaeus) larvae (Diptera: Stratiomydae) in Oil Palm Cake”, vol. 7, no. 1. Indonesian journal of Entomology, pp. 28-41. 2010.

[10]. S. Thomas, M. Ottoboni, C. Klootwijk, A. Ovyn, S. Deboosere, B. De Meulenaer, J. Michiels, M. Eeckhout, P. De Clercq, S. De Smet, “Nutritional Composition of black soldier fly (Hermetia illucens) prepupae reared on different organic waste substrates”, vol. 97, Journal of The Science of Food and Agriculture, pp. 2594-2600.

[11]. Collins, N., and Sulewski, C. 2011. Ostomy Wound Management. 10-13.

[12]. O. A. Paula de, E. D. S. Franco, R. R. Barreto, D. P. Cordeiro, R. G. Melo, C. M. F. de Aquino, A. A. Rodrigues, P. L. de Medeiros, T. G. da Silva, A. J. da Silva Goes, M. B. de Sousa Maia, “Effect of semisolid formulation of persea americana mill (avocado) oil on wound healing in rats”, Evidence- based Complementary and Alternative Medicine: Ecam, 2013, 472382. 2013.

[13]. D. Andrew, V. J. Smith, “Antibacterial free fatty acids: activities, mechanisms of action and biotechnological potential”, vol. 85. Appl Microbiol Biotechnol, pp. 1629–1642. 2010.

[14]. W. Dayong, S. N. Meydani, “Mechanism of age-associated up-regulation in macrophage PGE2 synthesis”, vol. 18. Brain, Behavior, and Immunity, pp. 487–494. 2004.

[15]. P. Eun-Jung, S. A. Kim, Y. M. Choi, H. K. Kwon, W. Shim, G. Lee and S. Choi, “Capric acid inhibits NO production and STAT3 activation during LPS-induced osteoclastogenesis”, vol. 6, no. 11. PLoS ONE, pp. 6:e27739. 2011.

[16]. N. Teruaki, M. C. Kao, J. Y. Fang, C. C. Zouboulis, L. Zhang, R. L. Gallo and C. M. Hung, “Antimicrobial property of lauric acid against Propionibacterium acnes: its therapeutic potential for inflammatory acne vulgaris”, vol. 129. J Invest Dermatol, pp. 2480–8. 2009.

[17]. H. Wen-Cheng, T. H. Tsai, L. T. Chuang, Y. Y. Li, C. C. Zouboulis and P. J. Tsai, “Anti-bacterial and anti-inflammatory properties of capric acid against Propionibacterium acnes: a comparative study with lauric acid”, vol. 73, no. 3. J Dermatol Sci, pp. 232-40. 2014.

[18]. Z. Zhen, S. Wang, Y. Diao, J. Zhang, D. Lv, “Fatty acid extracts from Lucilia sericata larvae promote murine cutaneous wound healing by angiogenic activity”. Lipids in Health and Disease. 2010.

[19]. A. Alma, D. Balgoma, M. A. Balboa and J. Balsinde, “Dynamics of arachidonic acid mobilization by inflammatory cells”, vol. 1821, no. 2. Biochim Biophys Acta, pp. 249–256. 2012.

[20]. P. C. Calder, “Polyunsaturated fatty acids and inflammation”, vol. 75, no. 3. Prostaglandins Leukotrienes and Essential Fatty Acids, pp. 197–202. 2006.

[21]. D. Julia, A. M. Szpaderska, L. A. Dipietro, “Neutrofil function in the healing woung: adding insult to injury”, vol. 92, no. 2. Thromb Haemost, pp. 275 – 280. 2004.

[22]. S. C. oliveira, C. A. Valenzuela, E. J. Baker, E. A. Miles, J. C. R. Neto and P. C. Calder, “Palmitoleic Acid has Stronger Anti-Inflammatory Potential in Human Endothelial Cells Compared to Oleic and Palmitic Acids”, vol. 62, no. 20. Mol Nutr Food Res, pp. e1800322. 2018.

[23]. J. Damjan and N. K, “Modern Cosmetics”, vol. 1. Ingredients of natural origin, a scientific view, Velenje, Slovenia: Sirimo dobro besedo d.o.o. 2018.

[24]. M. Renata and D. Mozaffarian, “Saturated Fat and Cardiometabolic Risk Factors, Coronary Heart Disease, Stroke, and Diabetes: a Fresh Look at the Evidence”, vol. 45, no. 10. Lipids, pp. 893–905. 2010.

[25]. G. Said, H. Harhar, D. Guillaume, A. Roudani, S. Boulbaround, M. Ibrahimi, M. Ahmad, S. Sultana, T. B. Hadda, I. C. Moussaoui, Z. Charrouf, “Chemical investigation of Nigella sativa L. seed oil produced in Morocco”, vol. 14, no. 2. Journal of the Saudi Society of Agricultural Sciences, pp. 172–177. 2015

[26]. D. C. V. P. Maria, G. d. C. Dieamant, S. E. C. Nogueira, D. Colombi, L. C. Di stasi, M. L. de Souza, “Effect of green Coffea arabica L. seed oil on extracellular matrix components and water-channel expression in in vitro and ex vivo human skin models”, vol. 8, no. 1. Journal of Cosmetic Dermatology, pp. 56–62. 2009.

[27]. ME. Nobre, AO, Correia, Mde B Borges, TM Sampaio, SA Chakraborty, Dde O Gonçalves, GA Brito, LK Leal, CF Felipe, DL Lucetti, RM Arida, GS Viana, “Eicosapentaenoic acid and docosahexaenoic acid exert anti-inflammatory and antinociceptive effects in rodents at low doses”, vol. 33, no. 5. Nutr Res, pp. 422-33. 2014.