

Capacity Building of the *Gerakan Ekonomi Kaum Ibu* (GEMI) Community Yogyakarta in Producing Bioinsecticides from Essential Oil-Producing Plants

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Article Info	Abstract
Article history: Received: December 30, 2025 Accepted: April 8, 2026 Published: May 31, 2026 Keywords: Bioinsecticide Essential oil Lemongrass Repellent This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License © 2026 Bubungan Tinggi: Jurnal Pengabdian Masyarakat	Mosquito-borne diseases frequently occur in tropical regions, such as Indonesia. The use of synthetic chemical repellents can pose health and environmental issues. Essential oil-producing plants, such as lemongrass (<i>Cymbopogon</i> sp.), have significant potential as safe, natural bioinsecticides. However, their utilization by the partner community remains limited to culinary spices or traditional beverages. This community service program aimed to improve the knowledge and skills of the Gerakan Ekonomi Kaum Ibu (GEMI) partner community in processing essential oil-producing plants to produce household bioinsecticides. This program was implemented using the ABCD (Asset-Based Community Development) approach, which involved mapping local essential oil plant assets followed by participatory training to transform these assets into household-scale bioinsecticide products. The impact of this program was evaluated using pretest and posttest approaches, with indicators including increases in average scores, shifts in the score distribution, and improved understanding of essential oil concepts. These findings suggest that the ABCD approach and participatory demonstrations can be used to support the transfer of applicable skills, as evidenced by an increase in the average score from 80.48% to 91% (a 10.52% increase), a clear shift in score distribution from the 70–80 range to 90–100, and the ability of all participants (100%) to produce both dry and wet bioinsecticides. The resulting bioinsecticide products have potential advantages, including the use of affordable local materials, simple production processes, environmental friendliness, and the potential to be developed into economically valuable, independent home-based enterprises. To cite this article: Tunjung, W. A. S., Pamungkas, K. N., Kurniawati, E., Prihatini, L., & Nuha, Z. K. (2026). Capacity building of the <i>gerakan ekonomi kaum ibu</i> (gemi) community yogyakarta in producing bioinsecticides from essential oil-producing plants. <i>Bubungan Tinggi: Jurnal Pengabdian Masyarakat</i>, 8(2), 507-519.

INTRODUCTION

Mosquitoes serve as a primary vector for transmitting various infectious diseases, including dengue fever, chikungunya, Zika, and yellow fever, which are primarily spread by *Aedes aegypti*. This species is widely found in tropical and subtropical regions, including

Indonesia, where environmental conditions support year-round breeding. The expanding geographical distribution of mosquitoes, driven by urbanization, human mobility, and climate change, continues to increase the global risk of disease transmission ([Lopez et al., 2025](#); [Kraemer et al., 2019](#)). The use of repellents is a common preventive measure, as they disrupt the mosquito's chemoreceptors located on its antennae and other sensory organs. Commercial repellent products generally contain synthetic active ingredients, such as DEET, picaridin, and IR3535, available in various forms, such as sticks, lotions applied directly to the skin, or liquid sprays. However, these chemicals pose potential health risks, such as skin irritation, and have negative environmental impacts owing to their bioaccumulative nature ([Brausch & Rand, 2011](#); [Gaudet et al., 2024](#); [Haleem et al., 2020](#)).

With growing awareness of safety and environmental sustainability, the use of natural materials, such as essential oils, as an eco-friendly bioinsecticide alternative has emerged. Essential oils contain bioactive compounds, such as terpenoids, phenols, aldehydes, and alcohols, which exhibit repellent properties by disrupting the nervous system and olfactory receptors of mosquitoes ([Başer & Buchbauer, 2015](#); [Nerio et al., 2010](#)). Numerous studies have shown that essential oils, including those from the *Cymbopogon* genus, are highly effective mosquito repellents. They have been further developed using modern formulation technologies, such as nanoemulsions and microencapsulation, to improve their stability and duration of action. Nevertheless, such developments are still mostly confined to the laboratory scale or rely on relatively complex technologies, making them difficult for the general public to adopt.

As a megabiodiverse country, Indonesia holds massive potential for developing essential oil-producing plants, with approximately 40 potential plant species, some of which have already been developed on an industrial scale ([Sofiani & Pratiwi, 2017](#)). Citronella (*Cymbopogon nardus*) and lemongrass (*Cymbopogon citratus*) are examples of plants that are easily found in local communities. They contain active compounds, such as citral, citronellal, and geraniol, which act as natural repellents ([Nerio et al., 2010](#); [Gaudet et al., 2024](#)).

Previous field observations showed the partner community affiliated with the *Gerakan Ekonomi Kaum Ibu* (GEMI) exhibits a high dependency on commercial synthetic mosquito repellents, such as mosquito coils and chemical sprays. Furthermore, preliminary observations revealed that despite the abundant availability of essential oil-producing plants, particularly lemongrass, their utilization remains strictly limited to basic culinary spices or traditional beverages. This situation is primarily driven by a lack of specific knowledge and the appropriate technological skills required to process these raw natural assets into functional bioinsecticides. Consequently, their functional and economic potentials have not been optimally utilized.

Several previous community service programs have explored the use of lemongrass as an insecticide, such as training in essential oil distillation and its application as a botanical pesticide in the agricultural sector ([Lina et al., 2021](#); [Nurmawati et al., 2022](#)). However, these approaches generally focus on technical processing aspects and often require specialized equipment, while lacking integration with practical, low-technology approaches and sustainable community economic empowerment. This indicates a gap between existing research outcomes and their implementation at the community level.

To address this gap, this study introduces a community-based approach by developing a simple, non-distillation method to produce bioinsecticides from locally available essential oil-producing plants. Unlike previous programs, this approach does not require complex equipment and is designed to be applicable at the community level. In addition, the program integrates bioinsecticide production with women's economic empowerment.

This program was conducted by Universitas Gadjah Mada and aims to improve community knowledge and skills in utilizing local plants to produce bioinsecticide products. The program also provides an alternative approach for environmentally based vector control and supports the utilization of local resources at the community level.

METHODS

Program Approach

This community service program employed the Asset-Based Community Development (ABCD) approach, emphasizing the mobilization of the community's existing assets and potential as the foundation for program development. The ABCD framework leverages community resources, specifically essential oil-producing plants, alongside local expertise and social networks, while prioritizing long-term program sustainability ([Najamudin & Al Fajar, 2024](#)). This approach was chosen for its ability to encourage active community participation in identifying and utilizing local potential. Participant selection in this community service program was purposive, focusing on local resources and community activities. The partner community, Gerakan Ekonomi Kaum Ibu (GEMI), consists of smaller groups called “rembug.” This program involved the rembug in Joho Hamlet, Jambidan Village, Bantul Regency, Yogyakarta. This group was chosen because of its members’ active involvement in cultivating essential oil plants, particularly red lemongrass, in home gardens. Some members have experience in producing value-added products, such as soap, from essential oils. These practices indicate resource availability and baseline knowledge, making rembugs a strategic target group for capacity building in the production of bioinsecticides from essential oil plants.

Tools and Materials

The tools required for this community service activity included cutting boards, knives or scissors, small bowls or containers, and porous burlap bags. The materials needed to produce the bioinsecticide-based air fresheners were categorized into two types: dry and wet. The dry materials comprised dried nutmeg leaves, lemongrass, fennel, star anise, cloves, ginger, kencur (aromatic ginger), and cardamom. The wet materials included citrus peels and fresh lemongrass.

Implementation Stages

1. Planning and Preparation Stage

This initial stage aimed to ensure the program's relevance to the partner community's needs and the availability of resources. Activities in this phase included field surveys and observations, coordination with relevant stakeholders, and the preparation of tools, materials, and implementation methods.

2. Socialization and Training Stage

As the core of the program, this stage aimed to improve the community's knowledge, awareness, and practical skills in utilizing essential oil-producing plants as natural bioinsecticides. The activity began with a session on essential oil-based bioinsecticides as eco-friendly mosquito repellents, including the mechanism by which volatile compounds disrupt insect olfactory systems.

Training was conducted participatively through interactive lectures, demonstrations, and hands-on practice. The training materials covered the identification of mosquito-repellent plants commonly found in the surroundings, such as lemongrass (*Cymbopogon* sp.), lavender (*Lavandula* sp.), basil (*Ocimum basilicum*), cosmos (*Tagetes* sp.), and Madagascar periwinkle (*Catharanthus roseus*),

as well as simple home-yard planting techniques as an environmental-based vector control effort.

Bioinsecticide production involved two approaches: utilizing dry and wet materials. For the dry method, plant simplisia or spices (e.g., dried lemongrass, cloves, cardamom, and star anise) were dried, placed into porous bags (sachets), and subsequently positioned at strategic indoor locations. For the wet method, fresh ingredients such as lemongrass, citrus peels, and kaffir lime leaves were washed and finely sliced to increase their surface area and maximize essential oil release, then placed in open containers. Crucially, wet materials were strictly separated from dry materials and periodically replaced to prevent decay.

All training phases were designed based on the principles of appropriate technology, keeping them simple, easily replicable, and utilizing local resources to ensure sustainable community adoption. Participants' understanding was evaluated using pre-tests and post-tests to measure the effectiveness of knowledge and skill transfer.

3. Evaluation Stage

This stage aims to measure the program's effectiveness, monitor its execution, and assess its overall success. The evaluation used a one-group pretest–posttest design with all the program participants. A total of 21 participants, all active members of the Gerakan Ekonomi Kaum Ibu (GEMI) community, were included through total sampling. The evaluation used structured pre- and post-test instruments with 10 multiple-choice and true/false questions (Table I). These instruments assessed the participants' knowledge of essential oils and their use as bioinsecticides. The same questions were administered before and after the training to measure improvements in understanding. In addition to quantitative data, qualitative data were collected through participants' verbal feedback during and after training to capture their responses, perceptions, and engagement. The evaluation focused on cognitive aspects, as reflected in changes in test scores, and psychomotor aspects, as reflected in the participants' ability to independently produce bioinsecticide products during practical sessions.

Table 1 Question items and answer types

No.	Questions Type	Question Type
1.	Do you know what essential oils are?	Multiple Choice
2.	Which of the following is not an application of essential oils?	Multiple Choice
3.	Can essential oils be used to repel mosquitoes?	Multiple Choice
4.	Are you aware of the natural sources of essential oils?	Multiple Choice
5.	Mosquitoes can be naturally repelled or killed using common household ingredients such as lemongrass, citrus peels, and cinnamon.	True/False
6.	The primary plant parts that serve as sources of essential oils include leaves, flowers, fruits, fruit rinds, stems, roots, seeds, and sap.	True/False
7.	Essential oils can be utilized as air fresheners and in aromatherapy candles.	True/False
8.	The following items can repel mosquitoes, except...	Multiple Choice
9.	The Indonesian term " <i>minyak atsiri</i> " is synonymous with essential oils.	True/False
10.	A defining characteristic of essential oils is that they are odorous, highly volatile compounds.	True/False

4. Sustainability Stage

The sustainability stage aims to ensure the program's long-term viability and to facilitate the continuous application of the community's newly acquired knowledge and skills. This sustainability is fostered by providing modules or leaflets that serve as practical guides detailing step-by-step instructions for bioinsecticide production, alongside easily accessible, replay able video-based instructional media. To further encourage the independent procurement of raw materials, the implementing team also distributed souvenirs in the form of ready-to-use dry repellent sachets, as well as mosquito-repellent and productive plant seedlings, specifically cosmos (*Tagetes* sp.), passion fruit, and cherry tomatoes, for the residents to cultivate in their yards.

Data Analysis

The collected data (pre- and post-tests) were analyzed using descriptive quantitative techniques. This involved calculating the central tendency (mean) and comparing the frequency distribution of the scores before and after the program intervention. The program's success indicators are based on a standard framework for evaluating nonformal training, which encompasses both cognitive and psychomotor domains. The cognitive domain focuses on remembering (knowledge), comprehending (understanding), and applying (application) what is learned. The psychomotor domain relates to the participants' skills and their capacity to act following the learning experience ([Gunawan et al., 2023](#)). The cognitive domain was defined by a minimum average increase of 10% in the participants' post-test scores compared to their pre-test scores. Meanwhile, the psychomotor domain was evidenced by the participants' ability to independently and accurately formulate and produce the bioinsecticide preparations.

RESULTS AND DISCUSSION

Socialization and Training Implementation

The socialization and training sessions were conducted on May 10, 2025, in Joho Hamlet, Jambidan Village, Bantul Regency, Special Region of Yogyakarta, involving 21 participants from the *Gerakan Ekonomi Kaum Ibu* (GEMI) community group. This program aimed to enhance the community's knowledge and skills in using essential oils as bioinsecticides and in processing local plants into value-added products. More broadly, this initiative contributes to achieving the Sustainable Development Goals (SDGs). Specifically, it supports SDG 3 (Good Health and Well-being) through environmental-based disease prevention efforts, SDG 5 (Gender Equality) through women's empowerment, and SDG 8 (Decent Work and Economic Growth) by unlocking the potential of local resource-based home enterprises.

The session commenced with a pre-test to assess the participants' baseline knowledge. Subsequently, the socialization materials covered the fundamental concepts of essential oils, their plant sources, and their applications as natural bioinsecticides. Scientifically, essential oils are natural volatile oils extracted from specific plant parts, such as leaves, flowers, bark, or fruits, typically through processes like distillation, and are characterized by their distinct aromas and high volatility. The bioactive compounds within them, such as terpenoids and phenylpropanoids, play a crucial role in their biological activities, including insect-repellent activity ([Başer & Buchbauer, 2015](#); [Nerio et al., 2010](#)). These repellents work by disrupting insects' olfactory receptors, thereby inhibiting their ability to detect hosts. The use of natural ingredients is widely recognized as safer and carries fewer side effects compared to synthetic alternatives ([Nurfadilah & Moektiwardoyo, 2020](#); [Qadafi et al., 2021](#)). As shown in Figure 1, the socialization phase focused on the fundamental concepts of essential oils and their mechanism as natural mosquito repellents.



Figure 1 Implementation of material presentation

The hands-on training focused on producing bioinsecticides as natural air fresheners, using two distinct approaches: dry and wet preparations. The plants utilized were not limited to lemongrass (*Cymbopogon* sp.) but also included other mosquito-repellent plants such as lavender (*Lavandula* sp.), basil (*Ocimum basilicum*), cosmos or marigold (*Tagetes* sp.), and Madagascar periwinkle (*Catharanthus roseus*). These plants are known to emit distinct essential oil aromas that deter mosquitoes ([Nerio et al., 2010](#)). These plants function naturally by releasing volatile compounds that disrupt insects' olfactory systems.

For the dry preparations, a variety of spices were used for their active compound profiles. Citronella, cloves, cardamom, fennel, *kencur* (*Kaempferia galanga*), nutmeg leaves, star anise, and ginger all provide essential oils or compounds known for their insect-repellent or insecticidal properties ([Ashokkumar et al., 2022](#); [Isman, 2020](#); [Mardiansyah et al., 2016](#); [Nerio et al., 2010](#); [Nguyen et al., 2026](#); [Noumi et al., 2023](#); [Regnault-Roger et al., 2012](#)). These dry ingredients were placed in porous sachets and positioned in corners of homes as passive mosquito repellents.

Conversely, wet ingredients such as mandarin orange peels, fresh citronella, and kaffir lime leaves were finely sliced to maximize the release of their essential oils. Citrus peels contain limonene and citronellal, volatile organic compounds (VOCs) that can disrupt mosquitoes' olfactory receptors ([Isman, 2020](#)). Kaffir lime leaves (*Citrus hystrix*) contain citronellal, linalool, and limonene, as well as VOCs that act as natural repellents ([Nerio et al., 2010](#)). These wet materials were placed in open containers to allow volatile compounds to diffuse freely into the air. Crucially, dry and wet materials were kept separate due to their differing characteristics. Participants were instructed to replace wet ingredients once wilted to prevent decay, which could otherwise harbor pathogens. The practical session allowed participants to formulate bioinsecticides independently, as seen in Figure 2. This applicative demonstration method proved effective in bridging the gap between theoretical knowledge and practical skill acquisition.



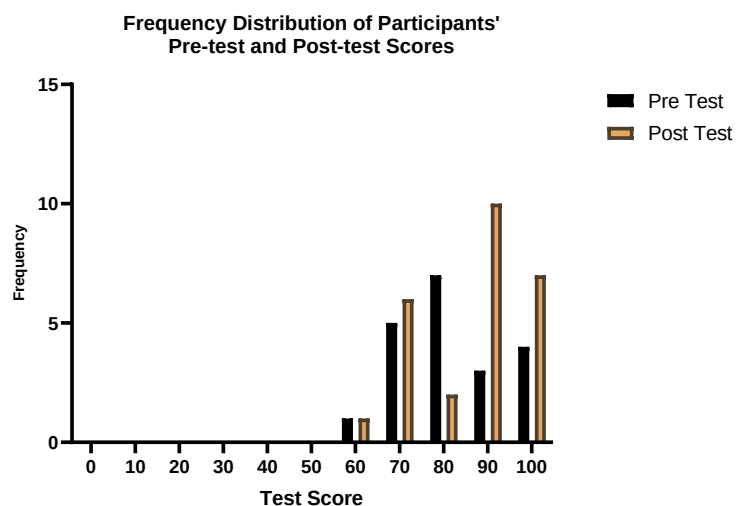
Figure 2 Hands-on practice in preparing bioinsecticides from dry materials

Analysis of Participants' Knowledge Improvement

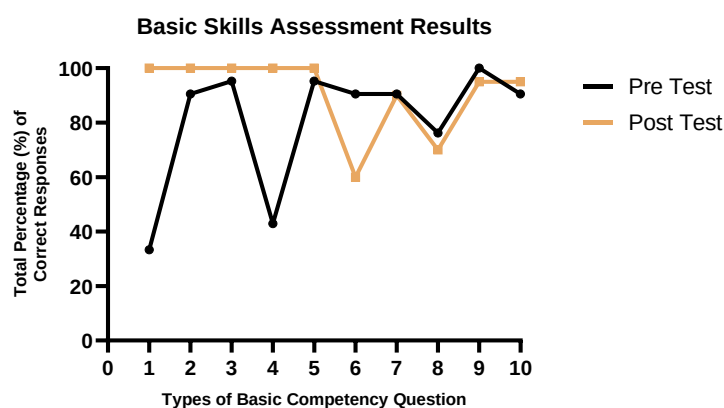
A primary indicator of the program's success is the enhancement of participants' knowledge, measured by comparing pre-test and post-test scores (80.48% and 91%). This assessment was conducted through two distinct analyses: the frequency distribution of total scores and the percentage of correct answers per question item (Table 2). Furthermore, the score distributions (Figure 3A) and detailed item-by-item analysis (Figure 3B and Table 3) further illustrate the participants' progress.

Table 2 Summary of program achievement indicators

Indicator	Before (Pre-test)	After (Post-test)	Increase (%)	Category
Average score	80.48%	91%	+10.52%	Achieved
Score distribution (dominant range)	70–80	90–100	Shifted	Achieved
Understanding of essential oil concept	33.3%	100%	+66.7%	High improvement
Understanding of natural sources	42.9%	100%	+57.1%	High improvement



(a)



(b)

Figure 3 (a) Frequency distribution of pre-test and post-test and (b) percentage of correct answers per item

The training evaluation results indicated a successful collective enhancement in understanding. The average score prior to the training (pre-test) was 80,48%, which increased to 91% following the training (post-test), reflecting a 10,52% improvement. The pre-test score distribution was relatively broad, with most participants scoring between 70 and 80. Following the intervention, the majority of scores shifted to the 90–100 range. These high post-test scores demonstrate that the socialization and training materials on essential oils and bioinsecticide production were exceptionally well-absorbed by most participants. The interactive delivery of materials, hands-on practice, and distribution of informative leaflets significantly helped participants understand the role of essential oils as natural mosquito repellents ([Sari et al., 2021](#)).

Furthermore, the largest increases in correct answers were for questions 1 (33.3% to 100%) and 4 (42.9% to 100%), indicating effective material transfer. Conversely, post-test scores for questions 6 (90.5% to 60%), 8 (76.2% to 70%), and 9 (100% to 95%) were lower than pre-test scores, suggesting suboptimal knowledge transfer or a slight decline in comprehension ([Nurlia et al., 2025](#)). The decline in scores for certain questions may be attributed to cognitive load. [Baxter et al. \(2025\)](#) explain that individuals possess a finite capacity for processing new information within their working memory. In the context of this program, the delivery of dense technical material on botany and terminology within a short timeframe likely imposed an excessive cognitive load on the participants. Moreover, [Preuss et al. \(2023\)](#) highlighted that memory retention and engagement in adult learning tend to prioritize practical, applied (psychomotor) experiences. During this activity, the participants' enthusiasm and focus were predominantly directed toward the hands-on practical session, which offered immediate tangible benefits. This indirectly resulted in a lower cognitive priority for retaining theoretical details that were perceived as less urgent for application.

The observed increase of 10.52% exceeds the minimum success indicator ($\geq 10\%$), indicating that the training intervention was effective in improving participants' cognitive understanding. However, several items (questions 6, 8, and 9) showed a decrease in correct responses, suggesting that certain concepts were not optimally delivered or may require improved explanation in future programs. The specific question items for the tests are in Table 3.

Table 3 Percentage of correct answers in the pre-test and post-test per question item

No.	Questions	Correct answers in pre-test (%)	Correct answers in post-test (%)
1	Do you know what essential oils are?	33.3	100
2	Which of the following is not an application of essential oils?	90.5	100
3	Can essential oils be used to repel mosquitoes?	95.2	100
4	Are you aware of the natural sources of essential oils?	42.9	100
5	Mosquitoes can be naturally repelled or killed using common household ingredients such as lemongrass, citrus peels, and cinnamon.	95.2	100
6	The primary plant parts that serve as sources of essential oils include leaves, flowers, fruits, fruit rinds, stems, roots, seeds, and sap.	90.5	60
7	Essential oils can be utilized as air fresheners and in aromatherapy candles.	90.5	90

No.	Questions	Correct answers in pre-test (%)	Correct answers in post-test (%)
8	The following items can repel mosquitoes, except...	76.2	70
9	The Indonesian term " <i>minyak atsiri</i> " is synonymous with essential oils.	100	95
10	A defining characteristic of essential oils is that they are odorous, highly volatile compounds.	90.5	95
Average		80.48	91

Analysis of Product Benefits

The household bioinsecticides produced by the GEMI members in Joho Hamlet offer several strategic advantages. Foremost, these products guarantee health and environmental safety because they are completely free of hazardous chemical solvents. Additionally, the products are derived from locally grown yard plants that previously held no commercial value. However, a limitation of these products is their relatively short effectiveness, necessitating periodic replacement of raw materials. The bioinsecticide-based air freshener produced during the training is shown in Figure 4.



Figure 4 Bioinsecticide-based air fresheners produced during the training

Based on observations and participants' verbal feedback, both the program's utility and the products' effectiveness were rated highly. All 21 participants (100%) successfully produced bioinsecticide products independently, indicating full achievement of the psychomotor learning objectives. Participants demonstrated strong motivation to further utilize essential oil-producing plants. The production procedures were deemed simple and easy to replicate, supported by the ready availability of raw materials in the surrounding environment.

The measurable improvement in knowledge and skills indicates that the program had a direct impact on community capacity building. Increased understanding of essential oil utilization may reduce dependency on synthetic repellents and promote environmentally friendly practices. Furthermore, the ability to produce bioinsecticides independently creates opportunities for small-scale, home-based enterprises, thereby supporting local economic resilience.

CONCLUSION

Implementation of this program improved the knowledge and skills of GEMI members in utilizing essential oil-producing plants as household bioinsecticides. This was demonstrated by an increase in the mean score from 80.48% to 91% (10.52%) and a shift in the score distribution from 70–80 to 90–100. In addition, all participants (100%) were able to independently produce both dry and wet bioinsecticides from local materials. These findings suggest that the ABCD approach and participatory demonstrations can support the

transfer of applicable skills. Further activities should focus on improving product stability and effectiveness, as well as developing packaging and marketing to support sustainable home-based enterprises. In general, the program contributed to SDG 3, SDG 5, and SDG 8 by improving environmental health awareness, empowering women, and supporting the development of local resource-based home enterprises.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

For community service articles with multiple authors, a short paragraph stating the contributions of each should be included. The following statement should be used: “Conceptualization, WAST; methodology, WAST, KNP, EK, LP, ZKN; formal analysis, WAST, KNP, EK, LP, ZKN; writing—preparation of the original draft, WAST, KNP, E.K, LP, ZKN; and others. Authorship should be limited to those who have contributed substantially to the reported work.

AI DISCLOSURE STATEMENT

The author used Paperpal during the preparation of this work for English language editing and proofreading. After using the tool/service, the author thoroughly reviewed and edited the content as needed and takes full responsibility for the content of the publication. The authors declare that this research was prepared, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

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