

## **Naturopathic Therapy Efforts: Potential Gingerol Content in Ginger (Zingiber officinale) As An Antidiabetic**

**Yuli Rahmawati Utami, Fitri Yani Rahmawati, Muna Az Zahra, Ida Maryati**  
Faculty of Nursing, Universitas Padjadjaran, Bandung, Jawa barat, Indonesia  
Email: ida.maryati@unpad.ac.id

### **Abstract**

Diabetes Mellitus (DM) is caused by unhealthy lifestyle habits and one of the treatment efforts is naturopathic therapy by utilizing the gingerol content in red ginger (*Zingiber officinale*). The role of nurses in complementary fields as providers of interventions can improve public health status. This narrative review aims to interpret research the potential content of red ginger as an antidiabetic. The research were carried out by identifying research questions, "what is the content of gingerol in red ginger as antidiabetic?". Literature search using EBSCO, PubMed, Springer Experiment, and Neliti. Used keywords "Nathuropathic therapy efforts AND Gingerol OR Red ginger OR Zingiber officinale AND Antidiabetic" obtained 140 articles. Then sorted with inclusion and exclusion criteria, so we obtained 7 articles stated that red ginger concerning intake doses per day of 1-3 and 6 grams can lower blood glucose which contains gingerol which stimulates insulin secretion and improves glucose tolerance. Red ginger as a natural ingredient is certainly easy to find, practical, has no side effects, and economical. It is necessary to conduct further research regarding the type of red ginger and the dosage that adjusted to the habits of the Indonesian people so not to cause confusion regarding the application process.

**Keywords:** Antidiabetic, naturopathic therapy, zingiber officinale.

## **Introduction**

One of the causes of death in the world is diabetes mellitus (DM) with such a large impact on people's lives and welfare in the long term (Saeedi et al., 2019). The World Health Organization (WHO, 2021) states that DM is also an important global health problem because it can cause severe morbidity and mortality. The cause of the increased prevalence of DM is the survival of unhealthy life such as early detection, self-management, and lack of physical activity in sports (Xing et al., 2020). Efforts that can be done in addition to maintaining self-management are by paying attention to therapy for clients that can maintain the stability of the body's health of people with DM, such as naturopathic therapy.

Naturopathy is a medical system that aims at primary care, treatment of disease, and the well-being of people related to health (Bradley et al., 2019). Naturopathic therapy as the basis of natural healing, one of the herbal plants that can be applied is red ginger. Red ginger has been identified as having gingerols and shogaols which are biochemically active compounds (Suk et al., 2016). The pharmacological benefits of red ginger in the prevention of obesity and diabetes can increase blood sugar tolerance, control lipid metabolism, suppress carbohydrates in the digestive system, and modulate insulin secretion and response in the body (Wang et al., 2017).

Research using a meta-analysis method shows that red ginger is assessed in the treatment of DM such as decreasing effective glycemic levels, lipids, and even anthropometry of DM patients, and does not provide significant side effects for consumers (Zhu et al., 2018). This is with research conducted by Huang et al., (2019) that red ginger has great potential in lowering glycemic levels and its complications because red ginger interacts with various molecular pathways involved in disease genesis, such as inhibition of multiple transcriptions. However, it turns out that in Indonesia, which already knows red ginger as a food or drink spice that has been passed down for generations, there are still many people who do not know the benefits of red ginger for

DM sufferers (Azizah et al., 2019). Efforts to explore the therapeutic capacity of nature by utilizing the content in red ginger need to be recommended for new studies by researchers continuously.

Naturopathic therapy by utilizing ginger content as an antidiabetic is one of the complementary therapies, where complementary therapy is an alternative therapy with natural products or called non-pharmacological therapy that is useful for overcoming health problems (Satria, 2013). This is evidenced by the results of research conducted by Radwan et al. (2020), that most people with diabetes mellitus in the United Arab Emirates follow a complementary therapy program from the start of being diagnosed to prevent complications. The role of nurses in the field of complementary therapy is to provide interventions based on intervention standards, where complementary therapies such as naturopathic therapy are a type of nursing intervention (PPNI, 2018). Therefore, naturopathic therapy can be used as non-conventional therapy that can improve public health status which includes promotive, curative and rehabilitative efforts with high quality, safety and effectiveness (Xie et al., 2019).

This reason is the main focus in the application of naturopathic therapy with the use of biodiversity such as red ginger which is widely grown in Indonesia which has antidiabetic properties. This review will focus on the findings that strengthen that red ginger has benefits for preventing and stabilizing the health of people with diabetes. Therefore, a review of articles on traditional plants, namely red ginger, which can be used as an antidiabetic naturopathic therapy material was carried out to identify and interpret research the potential content of red ginger as an antidiabetic.

## **Research Method**

This writing uses a narrative review with the aim of identifying and to research interpretation the potential content of red ginger as an antidiabetic in patients with diabetes mellitus (DM).

### Research stages

#### 1. Identify research questions

There is research related to gingerol content with DM conditions, that ginger contains active substances or ingredients such as gingerols, flavonoids and oleoresins (Sulistyoningsih, et, al., 2018). Gingerol and shogaol are phenol components that have functions as anti-inflammatory, anticancer and antitumor (Etika, et, al., 2017).

Carried out by identifying research questions, namely "what is the content of gingerol in red ginger as antidiabetic?".

#### 2. Identification of appropriate literature

##### 2.1 Literature Search Strategy

The literature search strategy uses several search engines, namely EBSCO, PubMed, Google Scholar, Springer Experiment, and Neliti.

##### 2.2 Literature Search

The literature search used the keywords "Nathuropathic therapy efforts AND Gingerol OR Ginger OR Zingiber officinale AND Antidiabetic".

##### 2.3 Total Articles Obtained

Articles obtained through several search engines with specified keywords, obtained 140 articles. The number of articles obtained from each search engine can be seen in the table 1 below.

**Table 1. List of Articles Obtained**

Search engine used	The Total Number of Articles Obtained
EBSCO	6 articles
PubMed	67 articles
Springer Experiment	31 articles
Neliti	62 articles
Total	140 articles

#### 3. Sortir Literature

Literature sorting was done by entering the keyword "Nathuropathic therapy efforts AND Gingerol OR Ginger OR Zingiber officinale AND Antidiabetic" in the EBSCO database, PubMed, Springer Experiment, and Research found EBSCO got 6 articles, PubMed got 67 articles, Springer Experiment got 62 articles, and Research found 5 articles. A total of 140 articles were obtained. Then sorting with inclusions, namely articles in Indonesian and English, publication year 2016-2021, research articles using experimental methods,

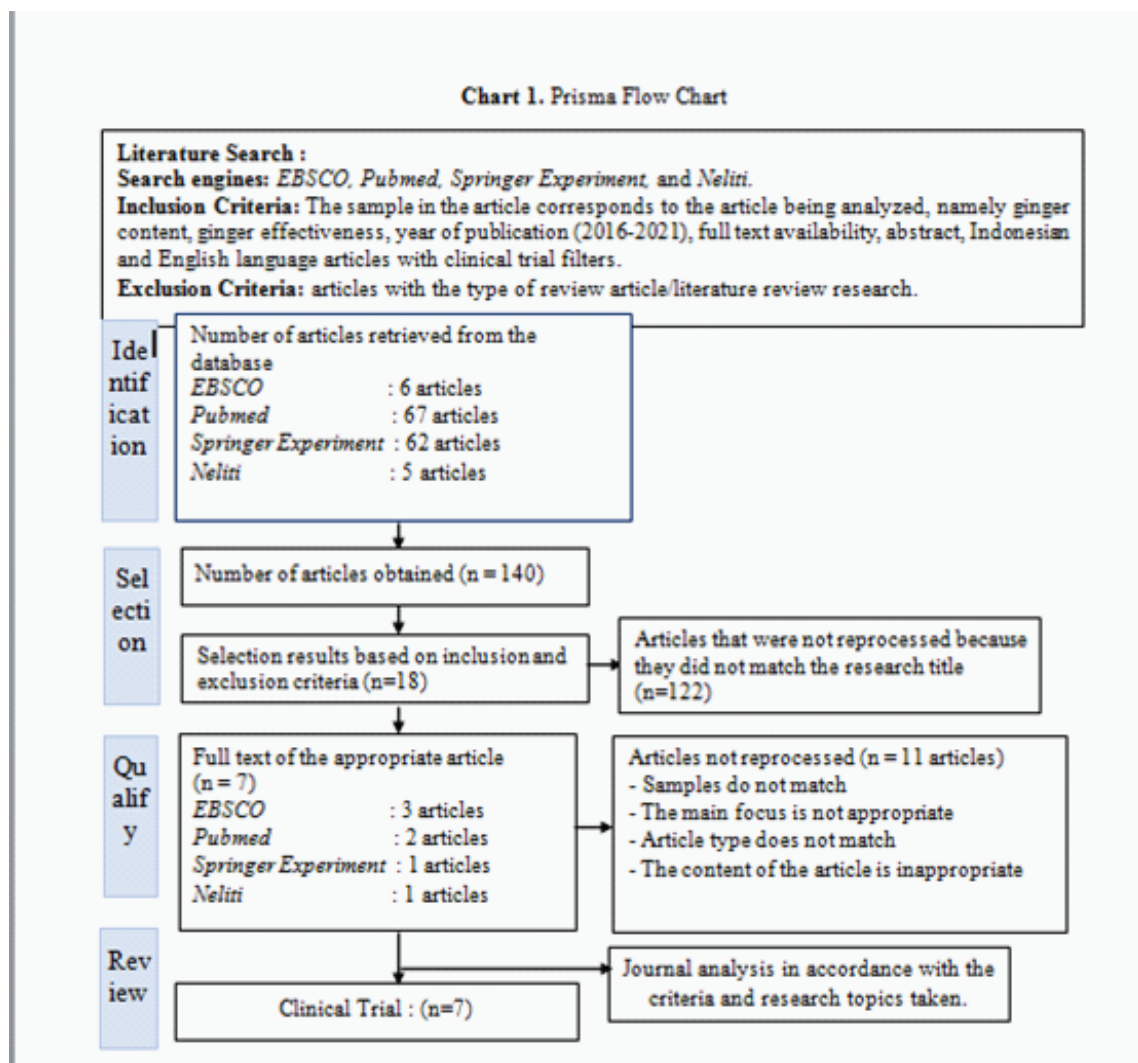
focusing on the literature on Naturopathic Therapy Efforts: The Potential of Gingerol in Ginger (Zingiber officinale) As Antidiabetic. The sample in the article corresponds to the article being analyzed, namely ginger content, ginger effectiveness, population and samples of diabetes mellitus patients. And obtained articles according to inclusion from EBSCO 3 articles, PubMed 2 articles, Springer Experiment 1 article, and Researching 1 article and overall obtained 7 articles with the type of clinical trial method.

**Table 2. List of Inclusion and Exclusion**

Criteria	Inclusion	Exclusion
Language	Indonesian and English	
Year of publication	2016-2021	
Type of literature	Articles with experimental research methods	Article review/literature review
Total articles that match the inclusion (n= 18 articles)		Total articles that do not match the title of the study (n= 122)

**Yuli Rahmawati Utami:** Naturopathic Therapy Efforts: Potential Gingerol Content in Ginger

Criteria	Inclusion	Exclusion
Literature focus	Naturopathic Therapy Efforts: The Potential of Gingerol in Ginger ( <i>Zingiber officinale</i> ) As Antidiabetic. The sample in the article corresponds to the article being analyzed, namely ginger content, ginger effectiveness.	
Population and sample	Patients with diabetes mellitus (DM).	The benefits of ginger on complications of other diseases.
Total articles according to the research topic Journal analysis in accordance with the criteria and research topics taken 7 articles		Articles that are not reprocessed (n= 11) <ul style="list-style-type: none"> <li>• The sample is not suitable</li> <li>• The main focus is not appropriate</li> <li>• The type of article is not appropriate</li> </ul>



## Results

After doing a search, we found 140 articles, but those that matched with inclusion criteria were found to be 7 articles. In detail the research that states the effect of red ginger consumption with a decrease in blood glucose levels can be seen in table 3, the literature review table with research articles collected in Indonesian and English with a clinical trial filter and has a parallel study design (Almasdy & Martini, 2016), double-blind pilot study (Carvalho et.al.,

2020; Carvalho et al 2021), in silico method (Bare et al., 2019), and experimental (Yanto, Mahmudati, Susetyorini, 2016; Al Hroob, et al. 2018). The research was conducted in four countries, Indonesia (Almasdy & Martini, 2016; Yanto, Mahmudati, Susetyorini, 2016; Bare et al., 2019; Suharto et al., 2019), Brazil (Al Hroob, et al. 2018; Carvalho et al 2020), and Jordan (Carvalho et al 2021), while the research sample used is humans with a number between 16-33 respondents and the number of respondents is rats 24 - 30 tails.

**Table 3. List of Research on Antidiabetic Ginger**

Author, year	Purpose	Design, Sample	Result
(Almasdy & Martini, 2016)	Knowing the effect of giving red ginger powder to patients with type 2 diabetes mellitus	Parallel designs with treatment and control groups are independent  33 people for 2 groups with details of 17 people in the treatment group and 16 people in the control group	Powdered red ginger was shown to reduce fasting blood glucose levels while powdered red ginger had no effect on postprandial blood sugar levels (GD2PP)
(Bare et al., 2019)	Analyzing the potency of 6-gingerol as a c-Jun N-terminal kinases (JNK) inhibitor	In silico method  The number of amino acid residues that interact with JNK, hydrogen bonds, and energy formed	Two amino acid residues that interact with 6-gingerol are predicted to have the ability to inhibit JNK performance. Inhibition is carried out by binding to the active site of JNK. This inhibition can be an alternative solution in the treatment of Type 2 Diabetes Mellitus (T2DM)
(Suharto et al., 2019)	Examining the effect of giving ginger ( <i>Zingiber officinale</i> ) on blood glucose levels in patients with diabetes mellitus	One group pretest – posttest design with 16 diabetes mellitus patients given ginger ( <i>Zingiber officinale</i> )	There are differences in blood glucose levels before and after administration of ginger in patients with diabetes mellitus
(Carvalho et al 2021)	Analyze the effectiveness of ginger in decreasing glycemic, lipid and anthropometric levels of type 2 diabetes mellitus patients	Double-blind pilot study of the type of randomized clinical trial with inclusion criteria with a sample size of 24 respondents	A total of 21 study participants used 1.2 g of ginger beneficial in reducing anthropometric and lipid levels within 30 days of follow-up, but did not reduce glycemic levels in respondents

Author, year	Purpose	Design, Sample	Result
(Al Hroob, et al. 2018)	Explore the effects of <i>Zingiber officinale</i> on kidney injury caused by diabetes in mice	An experimental model of rat diabetes with an intraperitoneal injection of streptozotocin from a ginger rhizome with a total sample of 6 normal rats and 24 DM rats	<i>Zingiber officinale</i> can improve oxidative stress that causes hyperglycemia, inflammation and apoptosis cell death and can maintain and prevent kidney function in the kidneys of DM mice
(Yanto, Mahmudati, Susetyorini, 2016)	To find out whether the giving of “wedang jahe” with doses of 4 and 6 (g/KgBW) can reduce blood glucose levels in white rats fed a high-fat diet (HFD) and its comparison with physical exercise	True experiment with Post test only control group  30 female white rats approximately 3 months old	Showed that giving 6 grams of ginger had a higher effect than 4 grams, however it was still lower when compared to exercise with an average value of glucose levels (control HFD = 110.84, M)
(Carvalho et.al., 2020)	This study aims to evaluate the effectiveness of ginger ( <i>Zingiber Officinale</i> ) in reducing blood sugar and lipid levels in people with type 2 DM.	Double-blind, controlled and parallel clinical trials in Brazil	The use of ginger can help in the treatment of people with DM and included in herbal medicine

Suharto et al., (2019) is in line with Zhu et al., (2018) which states that giving red ginger to diabetes mellitus patients has a good effect on glucose control, red ginger can be an alternative therapy for diabetes mellitus. Based on the analysis of various journals above, it can be concluded that there is an effect between red ginger consumption and lower blood glucose levels (Suharto et al., 2019). Evaluation the effect of red ginger (*Zingiber officinale* Roscoe) on diabetes mellitus was also proven through research by Zhu et al., (2018) from ten studies that met the inclusion criteria in 490 people it was found that red ginger powder can optimally lower blood sugar levels and improve insulin sensitivity. Because red ginger contains several components of active ingredients that have benefits in lowering blood glucose levels, namely gingerol and shogaol compounds which stimulate insulin production and improve carbohydrate and fat metabolism in the body (Yanto et al., 2016). These compounds are derivatives of phenolic compounds and flavonoids that act as antidiabetic.

## Discussion

According to Hamzah (2019), plants that have been shown to have the ability to lower blood sugar levels are >500 antidiabetic plants, containing flavonoid compounds, ginger, chromium, tannins, isoflavones, gingerols, and so on, this is in accordance with research of Bare et al., (2019) which states that there are two amino acid residues that interact with 6-gingerol which are predicted to be able to inhibit c-Jun N-terminal kinase (JNK) which makes an alternative solution in the treatment of type 2 diabetes mellitus, so that the majority of DM sufferers in Langsa City choose drugs. Herbal medicine derived from Family Medicinal Plants or “Tanaman Obat Keluarga” (TOGA) as a treatment for elevated blood sugar levels because herbal drug therapy has no side effects, is affordable, and easy to obtain. Based on the research of Amie et al. (2020) on the application of naturopathic practice related to the identification of physiological systems in the diagnosis and treatment of patients that the application of naturopathy uses an

integrative physiological systems approach for the diagnosis and treatment of chronic diseases. However, insulin therapy causes more side effects such as hypoglycemia, weight gain, and gastrointestinal disturbances compared to herbal drug therapy. This condition encourages the exploration of natural ingredients as a source of alternative medicine for DM therapy which has received permission from the World Health Organization (WHO) (Massi & Kallo, 2018). One of these natural ingredients is red ginger which is easy to find, practical, and economical (Wicaksono, 2015). Red ginger contains gingerols which are the largest polyphenol components such as 6-gingerol, 8-gingerol, and 10-gingerol. 6-gingerol has an antidiabetic function by stimulating insulin secretion and increasing glucose tolerance in type 2 DM rats (Hamzah, 2019). The phenol content makes this medicinal plant able to lower blood glucose levels for patients with diabetes mellitus without the need to fear the risk of side effects for the body due to the natural properties it contains (Wicaksono, 2015). Another benefit of red ginger is that it can be used as a herbal medicine in traditional treatment of various diseases, either used alone or in combination with other ingredients (Aryanta, 2019). This is supported by research by Mahmudati, (2016) which states that giving 6 grams of red ginger has a higher effect than 4 grams in lowering blood glucose levels, but will be lower when applied with exercise or giving balanced physical exercise. Meanwhile, another study showed that a daily intake of 1.2 grams of red ginger for 30 days can reduce blood sugar levels so that they are stable and can relieve oxidative stress due to hyperglycemia that triggers the development of micro and macrovascular complications of DM such as diabetic nephropathy. Research by Carvalho et al., (2021) and al Hroob et al., (2018) states the same thing that red ginger is an alternative for the treatment of DM because red ginger is effective in lowering blood glucose in patients with type 2 DM as a therapeutic potential in treatment with the same dosage rules. The dose 1.2 grams daily for 90 days. Another benefit, red ginger can lower triglycerides in doses of 1 to 3 g daily for day, by increasing HDL levels

to protect against atherosclerotic disease in diabetics. Red ginger is also considered effective in reducing lipids in people with type 2 diabetes. Consuming 1.2 grams of red ginger every day for 90 days can reduce LDL values in people with type 2 diabetes. This is in accordance with the research of Bare et al., (2019) regarding the interaction between 6-Gingerol as an inhibitor of c-Jun N-terminal kinase (JNK). Six gingerols are the largest content of red ginger (*Zingiber officinale* Roscoe (Zingiberaceae)) while JNK has a strategic function in metabolism in type 2 diabetes postprandial (Almasdy & Martini, 2016).

The role of nurses includes caregivers, community leaders, educators, advocates, and researchers (Kemenkes RI, 2017). Nurses provide health education for DM patients related to self-care and lifestyle changes so that patients can control blood glucose levels, nurses also play a role in reducing blood glucose including giving non-pharmacological therapy giving ginger to lower blood glucose (Pratiwi, 2016). The results of this literature review support the health team in implementing naturopathic therapy by utilizing red ginger content in clinical practice as an alternative treatment for DM sufferers. However, it is necessary to do further research on the types of red ginger and the dosage adjusted to the habits of the Indonesian people so as not to cause confusion regarding the application process.

## Conclusion

Naturopathic therapy can be done by consuming plants (plant based diet) as a form of treatment and one of the traditional plants that has antidiabetic activity is red Ginger (*Zingiber officinale*) which contains gingerol. Naturopathy therapy by utilizing the gingerol content red Ginger has been shown to lower blood sugar levels, but care must be taken to ensure that the correct dose is used. In addition, red ginger as a natural ingredient is certainly easy to find, practical, has no side effects, and is economical. In addition, the characteristics of research subjects from the literature obtained from foreign countries with the State of Indonesia certainly have

differences such as demographics, individual characteristics, and lifestyles such as food consumed, activities, and economic activities. Differences in subjects from several experimental studies applied to white rats also led to differences in giving the appropriate dose of ginger to reduce the risk of DM. So that it is hoped that it can be an alternative treatment that is easy, liked by the community, and for further research it can be focused on the dose patent which can be antidiabetic.

## References

- al Hroob, A. M., Abukhalil, M. H., Alghonmeen, R. D., & Mahmoud, A. M. (2018). Ginger alleviates hyperglycemia-induced oxidative stress, inflammation and apoptosis and protects rats against diabetic nephropathy. *Biomedicine and Pharmacotherapy*, 106, 381–389. <https://doi.org/10.1016/j.biopha.2018.06.148>.
- Almasdy, D., & Martini, R. D. (2016). Pengaruh Pemberian Serbuk Kering Jahe Merah Terhadap Pasien Diabetes Melitus Tipe 2 Pendahuluan Diabetes Melitus ( DM ) merupakan suatu kelompok penyakit metabolik dengan karakteristik hiperglikemia yang terjadi karena kelainan sekresi insulin , kelainan. *Jurnal Ipteks Terapan*, 3, 161–169. <https://doi.org/http://dx.doi.org/10.22216/jit.2016.v10i3.523>.
- Azizah, N., Purnamaningsih, S. L., & Fajriani, S. (2019). Land characteristics impact productivity and quality of ginger (*Zingiber officinale rosc*) in Java, Indonesia. *Agrivita*, 41(3), 439–449. <https://doi.org/10.17503/agrivita.v41i3.2321>.
- Bradley, R., Harnett, J., Cooley, K., McIntyre, E., Goldenberg, J., & Adams, J. (2019). Naturopathy as a model of prevention-oriented, patient-centered primary care: A disruptive innovation in health care. *Medicina (Lithuania)*, 55(9), 1–14. <https://doi.org/10.3390/medicina55090603>
- Bare, Y., Maulidi, A., Sari, D. R. T., & Tiring, S. S. N. D. (2019). Studi in Silico Prediksi Potensi 6-Gingerol sebagai inhibitor c-Jun N-terminal kinases (JNK). *Jurnal Jejaring Matematika Dan Sains*, 1(2), 59–63. <https://doi.org/10.36873/jjms.v1i2.211> .
- Carvalho, G. C. N., Neto, J. C. G. L., Nunes, L. C. C., Alencar, A. M. P. G., Marques, R. L. L., & Damasceno, M. M. C. (2021). Effectiveness of ginger in the treatment of type 2 diabetes mellitus: A pilot study of the randomized clinical trial type. *Aquichan*, 21(1). <https://doi.org/10.5294/AQUI.2021.21.1.5> .
- Fathamira Hamzah, D. (2019). ANALISIS PENGGUNAAN OBAT HERBAL PASIEN DIABETES MELLITUS TIPE II DI KOTA LANGSA. <https://doi.org/http://dx.doi.org/10.30829/jumantik.v4i2.5057> .
- Huang, F. Y., Deng, T., Meng, L. X., & Ma, X. L. (2019). Dietary ginger as a traditional therapy for blood sugar control in patients with type 2 diabetes mellitus: A systematic review and meta-analysis. *Medicine*, 98(13), 1–7. <https://doi.org/10.1097/MD.00000000000015054> .
- Kementrian Kesehatan Republik Indonesia. 2017. Profil Kesehatan Kabupaten Jember Tahun 2014. [www.depkes.go.id/resources/download/profil/.../3509](http://www.depkes.go.id/resources/download/profil/.../3509) Jatim Kab Jember 2014.pdf.
- Mahmudati, N. (2016). Wedang Jahe Brepotensi Menurunkan Risiko DM Tipe 2 (Studi pada Tikus Putih Betina Hfd).
- Massi, G., & Kallo, V. (2018). Efektifitas Pemberian Edukasi Dengan Metode Video Dan Focus Group Discussion (Fgd) Terhadap Tingkat Pengetahuan Pasien Dm Tipe 2 Di Klinikdiabetes Kimia Farma Husada Manado. *E-Journal Keperawatan (e-Kep)* , 6(1), 1–6. <https://doi.org/https://doi.org/10.35790/jkp.v6i1.25182> .
- M. Sulistyoningsih, R. R. dan A. A. S. (2018). Pengaruh Pemberian Jahe, Kunyit dan Salam Terhadap Kadar Asam Urat dan Glukosa Darah pada Bebek. *Jurnal Peternakan Indonesia*, 20(2), 78–83. <http://jpi.faterna.unand.ac.id/index.php/jpi/article/view/309/273>.

- Pratiwi, D. W. (2016). Hubungan Peran Perawat Sebagai Edukator Dengan Efikasi Diri Pada Pasien Diabetes Mellitus Tipe 2 Di Poli Interna RSD dr. Soebandi Jember. Skripsi, Digital Repository Universitas Jember, 164.
- Radwan, H., Hasan, H., Hamadeh, R., Hashim, M., Abdulwahid, Z., Gerashi, M. H., 75 Hilali, M. Al, & Naja, F. (2020). Complementary and alternative medicine use among patients with type 2 diabetes living in the United Arab Emirates. *BMC Complementary Medicine and Therapies*, 20(1), 1–12. <https://doi.org/10.1186/s12906-020-03011-5>.
- Redi Aryanta, I. W. (2019). Manfaat Jahe Untuk Kesehatan. *Widya Kesehatan*, 1(2), 39–43. <https://doi.org/10.32795/widyakesehatan.v1i2.463>.
- Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N., Colagiuri, S., Guariguata, L., Motala, A. A., Ogurtsova, K., Shaw, J. E., Bright, D., & Williams, R. (2019). Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Research and Clinical Practice*, 157. <https://doi.org/10.1016/j.diabres.2019.107843>.
- Satria, D. (2013). Complementary and alternative medicine: A fact or promise? *Idea Nursing Journal*, 4(3), 82–90. <https://doi.org/10.52199/inj.v4i3.1682>.
- Suharto, I. P. S., Lutfi, E. I., & Rahayu, M. D. (2019). PENGARUH PEMBERIAN JAHE (*Zingiber officinale*) TERHADAP GLUKOSA DARAH PASIEN DIABETES MELLITUS. *Care: Jurnal Ilmiah Ilmu Kesehatan*, 7(3), 76. <https://doi.org/10.33366/jc.v7i3.1363>.
- Suk, S., Seo, S. G., Yu, J. G., Yang, H., Jeong, E., Jang, Y. J., Yaghmoor, S. S., Ahmed, Y., Yousef, J. M., Abualnaja, K. O., Al-Malki, A. L., Kumosani, T. A., Lee, C. Y., Lee, H. J., & Lee, K. W. (2016). A Bioactive Constituent of Ginger, 6-Shogaol, Prevents Adipogenesis and Stimulates Lipolysis in 3T3-L1 Adipocytes. *Journal of Food Biochemistry*, 40(1), 84–90. <https://doi.org/10.1111/jfbc.12191>.
- Wang, J., Ke, W., Bao, R., Hu, X., & Chen, F. (2017). Beneficial effects of ginger *Zingiber officinale* Roscoe on obesity and metabolic syndrome: a review. In *Annals of the New York Academy of Sciences* (Vol. 1398, Issue 1, pp. 83–98). Blackwell Publishing Inc. <https://doi.org/10.1111/nyas.13375>.
- Wang, X., Wang, S., Sun, L., & Qin, G. (2020). Prevalence of diabetes mellitus in 2019 novel coronavirus: A meta-analysis. *Diabetes Research and Clinical Practice*, 164, 1–7. <https://doi.org/10.1016/j.diabres.2020.108200>.
- Wicaksono, A. P. (2015). *Zingiber Officinale* terhadap Kadar Glukosa Darah Puasa dan Postprandial pada Tikus Diabetes Majority | (Vol. 4). <https://doi.org/https://doi.org/10.33366/jc.v7i3.1363>.
- Xie, X., Lu, L., Zhou, X., Zhong, C., Ge, G., & Huang, H. (2019). Complementary therapies in clinical practice effect of gua sha therapy on patients with diabetic peripheral neuropathy: A randomized controlled trial. *Complementary Therapies in Clinical Practice*, 35, 348–352. <https://doi.org/10.1016/j.ctcp.2019.03.018>.
- Yanto, A. R., Mahmudati, N., & Susetyorini, Rr. E. (2016). SEDUHAN JAHE (*Zingiber officinale* Roscoe.) DALAM MENURUNKAN KADAR GLUKOSA DARAH TIKUS MODEL DIABETES TIPE-2 (NIDDM) SEBAGAI SUMBER BELAJAR BIOLOGI. 2. <https://doi.org/http://eprints.umm.ac.id/id/eprint/34530>.
- Zhu, J., Chen, H., Song, Z., Wang, X., & Sun, Z. (2018). Effects of Ginger (*Zingiber officinale* Roscoe) on Type 2 Diabetes Mellitus and Components of the Metabolic Syndrome: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. In *Evidence-based Complementary and Alternative Medicine* (Vol. 2018). Hindawi Limited. <https://doi.org/10.1155/2018/5692962>