

# ABG Point of View in Lemongrass and Ginger Potency for Commercialization as Herbal with Anti-Diabetic Claim in Indonesia

Hinedreana F.M. Pranoto<sup>1\*</sup>, Maria D.P.T. Gunawan Puteri<sup>1</sup>, Victor Sahat Ringoringo<sup>2</sup>

<sup>1</sup> Department of Food Technology, Faculty of Life Sciences and Technology, Swiss German University, The Prominence Tower, Tangerang, 15143, Indonesia

<sup>2</sup> Chief Business Development and R&D, PT. Deltomed Laboratories, The Mahitala Building, Tangerang, 15320, Indonesia

\* Corresponding Author: [hinedreana.pranoto@student.sgu.ac.id](mailto:hinedreana.pranoto@student.sgu.ac.id)

## ABSTRACT

Diabetes mellitus is a general disturbance of metabolism and has been a major public health issue in Indonesia. Indonesia has numerous medicinal plants that are used in traditional medicine. Lemongrass and ginger are two of the medicinal plants that show anti-diabetic potency, where they are developed into an anti-diabetic product and later will be commercialized into a health product. But there are some challenges in commercializing the product. This study aimed to identify the bridge gap between research and commercialization by knowing the point of view of ABG (Academic, Business and Government). A literature review and an interview were conducted in this study. As a result, both research and empirical is needed, between Academic, Business and Government need a real cooperation, equalize perceptions and also awareness in herbal products, there is always the possibility of lemongrass and ginger being commercialized as an anti-diabetic product, but there should be a consideration in mixing them, the shape, the trends, the stability, and shelf life of the product, the prospect of herbal products in the future is very bright. In addition, herbal products can be sold both domestically and internationally depending on how smart we are in making the herbal products. In conclusion, a student or researcher should think carefully about creating a product and have entrepreneurial thinking.

**Keywords:** Lemongrass, Ginger, Anti-diabetic, In-depth Interview, Development, Prospect, Strategy.

## 1. INTRODUCTION

Diabetes is a general term for disturbances of metabolism for which the main finding is chronic hyperglycemia. Diabetes is classified into 2 types: type 1 diabetes which leads to absolute insulin deficiency and type 2 diabetes which can range from predominant insulin resistance with relative insulin deficiency to prevailing defective secretion with insulin resistance and others [1]. Diabetes in Indonesia has been considered a major health problem [2]. Indonesia was the seventh-ranked country with 8.5 million diabetes patients and has moved up to the fifth-ranked country with a significant number of people with diabetes [3].

Indonesia is one of the countries with the most biodiversity that has more than 30,000 species of medical

plants that are used as traditional medicine or Jamu [4] or as herbal products. In Indonesia, herbal products are usually sold as traditional medicines or herbal drinks and not as processed food [5]. Traditional medicines are divided into 3 groups: Jamu, Standardized Herbal Medicines (OHT), and Fitofarmaka.

Amongst various medicinal plants, there is a lot of research and study regarding lemongrass and ginger. It is shown that lemongrass and ginger have been studied for the presence of  $\alpha$ -glucosidase inhibitory activities [6], helps to inhibit diabetes [7], and also have been found to show a high anti-diabetic potency.

Due to the potential of lemongrass and ginger, this research review became a part of the research roadmap in Swiss German University, where one of the current

research roadmap is to develop an anti-diabetic product using lemongrass as the base and ginger as a flavor. In addition, this product will be directed and commercialized to become a health product in the coming time. In carrying out this research roadmap, a business partner/ herbal industry was needed to commercialize the product.

Unfortunately, there are some challenges in commercializing the products due to the compliance of the regulations that are made, the quality standards of medicinal plants that are getting tighter [8], and also a gap between research and commercialization of the products.

Therefore, before a product is commercialized, the point of view of ABG and a strategy is needed. This research objective was to identify the bridge gap between research with commercialization.

## **2. MATERIALS AND METHOD**

This in-depth interview was done online by zoom with several herbal experts with ABG's (Academic, Business, and Government) comprehensive lookout. For academics, the parties that are interviewed are people that work or do research on herbal products. While for the business field, the interviewed parties are people that work in the herbal company and a therapist that uses herbal in the product, and for the government field, it is a staff of the regulatory from BPOM that were interviewed. In total, there are 5 respondents for this interview.

The discussion resulted in knowing more about the usage of herbal products in Indonesia and how they were sold, how to deal with the problems, the efficacy of lemongrass and ginger that are known, the potency of both plants as herbal products, and the prospects in the future. The results of the in-depth interview were then compiled and compared with the literature, and a commercialization strategy was made.

## **3. RESULTS AND DISCUSSION**

For institutions or universities that have the idea of making a product from herbal plants and want to commercialize them as health products, they need a business partner/ herbal industry to commercialize these products so that they know in which form are applicable to be commercialized. Therefore, in-depth interviews are conducted, to answer the question about the development and prospect of herbal products in Indonesia with the hypothesis that we need some adjustments and problem solving to commercialize a product.

In this interview, there are several topics to be done, such as the role of each field in the herbal world in Indonesia, the process of herbal development in Indonesia, the downstream of research, herbal products for anti-diabetic, lemongrass and ginger for anti-diabetic herbs, prospects of herbal products in Indonesia, herbal products marketing, sales of herbal products at the hospital, and herbal product commercialization process.

### ***3.1. The Role of Each Field in the Herbal World in Indonesia***

Overall, each profession has a different point of view of its role in the herbal world that can refer to table 1. In the academic field, there is a researcher and the Head of Academic Research and Community Service of a national private university (Expert 1). His role is doing some research in the herbal field, especially from mangroves. Next, there is the Head of Chemical Engineering & Lecturer of Herbal and Traditional Industry of a national private university. His role is being a lecturer and doing some research and some joint research that is related to herbal medicine (Expert 2).

For the business field, there is Chief Business Development and R&D in a national herbal company (Expert 3). His role is as a pharmacist, experience in the herbal industry and business in research and development of herbal products. Now he also sits at the secretariat of GP Jamu related to research and development and scientific herbal medicine. In addition, there is also a medical doctor and also an herbal therapist (Expert 4).

Lastly, in the government field, the study interviewed a staff from a technical implementation unit from the POM Agency as Head of Information at Semarang, Central Java, Indonesia (Expert 5). Balai POM's function is to control drugs and food circulating in Central Java drugs and food is not only about that but include medicine, traditional medicine, cosmetics, health supplements, and food.

Every source has almost the same view in improving the market competition position of Indonesian herbs. From the academics side, they supported the market with scientific research, educating the new generation to have sufficient insight to develop herbs, and also inspiring the new generation to do more research in the herbs field to improve herbal medication. While from the business and government side, they will support the market by giving seminars and education about using herbs and make sure the products are safe and follow the standard regulations.

**Table 1** The Role of Each Field in the Herbal World in Indonesia

Topics	Academic		Business		Government
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
<b>The role in herbal world</b>	Researcher and Head of Academic Research and Community Service	Researcher and Lecturer in Herbal and Traditional Industry	Business Development and R&D in herbal company	Medical doctor and also a herbal therapist	Head of Information
<b>The role in improving the position of Indonesian herbs in market competition</b>	Support them from the scientific side, Educating and inspiring new generation		Speak in several seminars and more activities work as an individual		Audit herbal product to make sure it is safe for consumer and can be marketed widely

### ***3.2. The Process and Downstream of Herbal Development in Indonesia***

Based on table 2 and 3, the government side is not being asked because at Balai POM Semarang their work is only to control, audit the products, and give the result to the central BPOM later on. They do not focus on the research, and downstream of the product as central BPOM did.

From the result, academics and business have different thoughts, wherefrom the academic side, the important steps they need are the natural resources, laboratory process, standardization, safety, and production.

While from the business side, they need medical aspects (how many samples that is need, seeing the needs in the market), then the marketing aspects (market size, competition, and prize (raw material sources and others)), R&D, manufacturing aspects (to check the safety, to check the new ideas, the ability to develop, following the standard, and can produce the product with the existing facilities or not (if not the idea can be toll manufacturing to other company)), then it will go to financial aspects (to see if it is profitable for long term) and regulatory aspects (if can it be registered). Because in developing new products, it is expensive, where when we do not do the pre-development, it will be expensive and useless if there are problems. In addition, they also need real cooperation from the academics, business, government and community.

The factors that need to be considered in the steps above is to equalize perception between academics, practitioners, businesses/industry, and government, then the awareness of the safety and usage of the natural resources and pay attention to industrial organization aspects.

In starting a research, both empirical and scientific research is needed, because almost all herbal medicines are using empirical data and to support it, research needs to be done and to be considered carefully for the future of the new product in the market by pre-development aspects assessment, so it can be potential for the success of the product development. Additionally, even if there is empirical data or local wisdom, we as future researchers also need to have a sense of knowing the importance of herbs in Indonesia by confirming the truth and can raise the level of Indonesian products from Jamu to at least OHT or even Fitofarmaka.

In table 2, about the regulations as a guideline in the development, for academic, they said that not only to follow the general rules but also to protect and promote the products and also as the booster for the research while for business they are very concerned about complying with the government regulations because those regulations are used to protect, and promote the product. Additionally, the regulations in medical education are also important.

In table 3, both academics and business are directly involved in research but for academics, they are not yet ready downstream due to some steps that still need to be done before the commercialization. For business, some companies always have a product to be commercialized where the products have been developed and registered to BPOM by choosing a long life cycle of the product characteristics to have a good and correct medical aspect

assessment to ensure the usage of the product so it will last long. While for other small industries or company, they are not currently doing downstream due to the service-based research because it is a government program so the sustainability and future program will not show results.

<b>Table 2</b> The process of herbal development in Indonesia		
<b>Topics</b>	<b>Academic</b>	<b>Business</b>
<b>Important steps in herbal product development</b>	Laboratory process, standardization, natural resources, safety, production	Real cooperation from ABGC (academics, business, government, community), and pre-development product aspect assessment
<b>Factors to be considered</b>	Equal perceptions and awareness (natural resources and safety)	Pay attention to the resources of our industrial organization and equalize perception
<b>Regulations as a guideline in the development</b>	It does not only regulate for the products to follow the general rules but also protect as well as to promote the products and the incentives of the research	Very concerned about complying with government and medical education regulations
<b>In starting the research topic, should be based on</b>	Coordination, communication and research background evidence	Based on pre-development aspect assessment, the needs and users (doctors/health workers who are familiar with herbs)

<b>Table 3</b> The Downstream of Research		
<b>Topics</b>	<b>Academic</b>	<b>Business</b>
<b>The need of empirical or scientific data before new research on herbs</b>	From local wisdom we can explore Indonesian natural potential herbs, but need to have sense in knowing the importance of the herbs, raise the level and research should still be done in order to confirm the truth	Do not just look at research from the laboratory but also see from other perspective aspect
<b>Direct involvement in research</b>	Yes, but not for down streaming yet (some steps that still needed to be done)	The products have been developed and registered properly.  Yes, but not currently for downstream(service-based research)

### ***3.3. Herbal Products for Anti-diabetic and Lemongrass and Ginger for Anti-diabetic herbs***

Based on table 4, all profession have same perspective, that currently the usage of herbal products in Indonesia are stable or even increasing due to the support of BPOM in helping to give permit the use of herbs, and in many cases, people are looking for alternative herbal

medicines, and also due to this pandemic of Covid -19 to increase the immune body.

While herbal products for anti-diabetic, they can see the potential in the Indonesian market because diabetes in Indonesia is very high where it is almost 20% of the population especially diabetes type 2, so people would look for a solution with herbal product in parallel or as conjunction therapy with modern medicine such Metformin and other agents. Additionally, Indonesia has

a lot of herbal potency for anti-diabetic, we just need to observe and learn more about the potency and if we want to enter herbal medicine in the market, the potency is quite large enough. Right now, there are already 5 Obat Herbal Terstandar and 6 Fitofarmaka for anti-diabetic products that have been proven by BPOM.

The shape of the product really affects the popularity of the product, where the easier it is to consume the more people will buy the product because many people like to use the practical once than the long method of consumption such as a tablet, capsule, or syrup, in addition education of the product is needed and important.

In their opinion, the popular herbal plants to be commercialized with the anti-diabetic claim are *Orthosiphon aristatus* (Daun Kumis Kucing), Chinese petai leaves, bitter leaves, *Clinacanthus nutans* (Dandang Gendis), bitter melon, and many other more.

The usage of lemongrass and ginger in Indonesia, refer to table 5, all the sources said that they are widespread and will continue to grow because both plants have been studied, mostly used as food and beverages, both of the plants are cultivated properly and well-taken

care, and the economical selling value is good, so many people used them. The efficacy of both plants are also well known and it can be seen in Table 5, where for ginger, it is for cough, sore throats, cooking, increasing the immune body, body warmer, and many others, while for lemongrass it is for aromatherapy, anti-inflammatory, anti-asthma, and others.

Additionally, there is always a potential for lemongrass and ginger to be commercialized as anti-diabetic products, but there should be a consideration in having a proper and intensive education, mixing them, the shape of the packaging (capsule, tablet, syrup, or drink), the stability of the product, and shelf life. Like for example, in tablet, although the aroma of the lemongrass and ginger is gone the shelf life and stability of the product can be a maximum of 2 years while if it is in form of a drink, the cost is higher due to the bottling and the maximum shelf life is only 1 year, so as a student or a researcher, we need to think carefully in making a product. In addition, gingerol and shogaol do not have the ability as anti-diabetic, so maybe the ginger can be used as a flavor or added as a hot sensation and the lemongrass as the base product.

**Table 4** Herbal Products for Anti-diabetic

<b>Topics</b>	<b>Academic</b>	<b>Business</b>	<b>Government</b>
<b>Current use of herbal products</b>	Increasing and supported by BPOM and many people are looking for alternative herbal medicines	Currently is stable especially during this pandemic	Increasing
<b>The potential of herbal products with anti-diabetic properties in the Indonesian market</b>	Indonesia has a lot of herbal potency and we must explore these potential  It will sell well, a lot of people who want a solution for diabetes that is safe and cheap	Diabetes type 2 is very high, if we want to enter herbal medicine that can help diabetics the market is big and the potential for anti-diabetes is quite large	It already exists, even in Indonesia, there is 5 OHT and 6 Fitofarmaka for anti-diabetic product
<b>Popular herbal products/plants to be commercialized as herbs with anti-diabetic properties</b>	<i>Orthosiphon aristatus</i> (Daun Kumis Kucing), lemongrass, ginger, Chinese petai leaves, pineapple bromelain, telang flower, kelakai and quite many other plants as alternatives to diabetes	Dandang Gendis ( <i>Clinacanthus nutans</i> ), mahogany seeds, papaya leaves and other bitter leaves, bitter melon, cinnamon, Sambiloto, brotowali, cinnamon, and many other more	Aloe Vera, bitter melon, sambiloto
<b>The shape of the product affects the popularity of the product</b>	Very influential, because people want something fast and instant.	Mostly in the form of tablet because it is more practical to use and education is needed	The easier it is used and consumed many people will buy it

**Table 5** Lemongrass and Ginger for Anti-diabetic herbs

Topics	Academic	Business	Government
<b>The use of lemongrass and ginger for herbs in Indonesia</b>	It is very widespread and will continue to grow (the two plants have been studied a lot)	Mostly used in food and beverages	It is very widespread
<b>Efficacy of lemongrass and ginger are known</b>	Ginger is to warm the body, increase immune body, cough, sore throat, and others, while lemongrass it is for aromatherapy	Ginger used for cooking, essential oil, flatulence, colds, mild analgesics, while for lemongrass is for Anti-inflammatory	Ginger is used as body warmer, anti-nausea, while lemongrass is for anti asthma
<b>Information about the anti-diabetic properties for lemongrass and ginger</b>	Have heard about it, but do not know about the mechanism, the work to treat diabetes, for what type of diabetes and others	Yes, but for ginger bioactive compound (gingerol and shogaol) are not efficacious as hypoglycemic agent	Does not know about the information
<b>Potential for commercializing anti-diabetic products from lemongrass and ginger</b>	There is always a potential, one thing that should be considered when they are mixed	There is always a potential, as long as in good packaging, good stability, shelf life, there is proper and intensive education and clinical trials become commercialization capital modal	There is always a potential

### 3.4. Prospects of Herbal Products in Indonesia

The prospects of herbal in Indonesia according to table 6, all the sources have the same thoughts that it is very bright, and will continue to keep increasing as long as the source is still there and when we have the scientific research, then it is going to be easier to market it globally.

In addition, especially in this pandemic, many people are selling herbals in online shop and it is increasing rapidly. Additionally, the herbal market is going to be high if the selection of products follows the trends, flows properly, sells it in the right momentum, and the entrepreneurial spirit/ think should go beyond other than the ability to mix or produce products.

**Table 6** Prospects of Herbal Products in Indonesia

Topics	Academic	Business	Government
<b>Business/ sales of herbal products prospects in the present and in the future</b>	Very bright and will continue to increase, when we have scientific data it will be easier to penetrate the market in global and as long as the source is still there	It is good and continue to rise (if the selection product well, follow the flow well, right momentum and education and research are carried out continuously)	Will increase, especially in this pandemic where online shop all increase rapidly

### 3.5. Other specific topics

Some topics are only to sources from the angle of Business and Government because in this part it is more about the marketing, the sales at the hospital, and the regulations about the commercialization process.

<b>Topics</b>	<b>Business</b>	<b>Government</b>
<b>Herbal products can be sold to other countries or only in Indonesia</b>	Local domestic market is the most important and main market but the world is getting more borderless so we are concern about the globalization of the products	Local domestic market is the most important but export and import product is also being done
<b>Herbal products are included in the hospital</b>	If it is herbal drink is only limited to the cafeteria but if in the form of OHT or Fitofarmaka  When the hospital is filled with doctors that have same mind set about herbs then it is use according to doctor's prescription and available at the pharmacy	Do not think it can, but if the Herbal Tourism House and the drug research center can do it
<b>Regulations that must be met by herbal companies in registration</b>	Depends on what we register (Jamu, OHT, or Fitofarmaka) and adjust with the existing categories	Minister of Health Regulation No. 14 of 2021 and several registration data from Central BPOM
<b>Failure to register herbal products in general</b>	Production and distribution If the company is small, its marketing problem	Several data that not comply with the standard from BPOM / the product audit get grade C

On the topic of herbal product marketing in table 7, it can be concluded that herbal products can be sold outside and inside Indonesia, but the main focus right now is in Indonesia in the local domestic market. In addition, for business it is said that the world is getting more borderless, so they are very concerned about the globalization of their products. So, the development of the international market remains their concern because it is the future of the company, not only depending on the domestic market but also being open to markets abroad. Some of their products have been through several countries such as Malaysia, Singapore, Thailand, Cambodia, Laos, Vietnam, soon in Philippines, Brunei, Timor Leste, Africa (Yemen), Nigeria, Egypt, Saudi Arabia, and also Europe (Hungary and Bulgaria). Based on the regulatory requirements, Indonesia and other countries are the same as strict because Indonesia is already included in the Global herbal Medicine Standard, so the one that is regulated by BPOM is already in line with ASEAN standards. Where the ASEAN Common

Technical Dossier for traditional medicine has also followed the standards that exist in Europe or America, if they relate it to Europe (EMA), they have follow the same standards, so they can register in Hungary but it is very strict, where they need 1 year more to complete the existing registration requirements.

Then on the sales of herbal products at the hospital, the sources have different opinions about it. Where for business sources, if it is an herbal drink it is only limited to the cafeteria of the hospital and can be recommended verbally or from doctors or nurse, but when it is in the form of Fitofarmaka or OHT then the usage can be according to doctor's prescription and it will be available at the pharmacy not in the canteen or cafeteria, in addition as long as the hospital is filled with doctors that have the same mind set about herbs then it can be sold at the hospital.

While from the government side, herbal products cannot be included in the hospital, but if it was in Herbal

Tourism House and the drug research maybe they can. In Central Java there an institute called the Indonesia Medicinal Plant Research Institute, where they research on herbal medicines and scientific medicine (example headache, later they will prescribe it in herbal forms like ginger, or laos in dosage that needed to be stew), and there is also WKJ (Wisata Kesehatan Jamu) in Tegal district, where they receive at least 30 patient per day to get an herbal treatment that has been proven in the manufactured products, in WKJ there is a doctor who is learning about herbs that prescribed the treatment.

Lastly, about the commercialization process of herbal products. It can be seen that as an herbal industry they follow the regulations depending on what product that they want to register (Jamu, OHT, or Fitofarmaka) and adjust it with the existing regulation of the categories and for the government sources, they added that there is a new regulation regarding the licensing of the minister of health regulation number 14 of 2021 but they have not been able to go through it all because there are so many of them.

When it is related to IOT (Traditional medicine industry) facilities for production, it needs to have a permit from the minister of health (national scale). The provincial-scale UKOT (Small Traditional medicine Business) then they need to have permits from the OSS/DPMPTSP (One Stop Integrated Investment and Licensing Service) an agency that take care of licensing but there is a technical unit that supports the background knowledge about traditional medicine in the health office later, where it will be supported by the local health office, and for small-scale UMOT (Micro Traditional Medicine Business), if there is a district or city, then they need the permits from the district DPMPTSP. Each of the productions has different requirements to be registered based on BPOM and Kemenkes. In addition, most of the time the industries failed to register their product to BPOM and Kemenkes because their product audit is graded C (value of the infrastructure, the result of production test, labeling, what additives are used, and others) and because of production, distribution problems, and lack of marketing strategies for small industries.

### **3.6. Based on Literature**

After an in-depth interview, the next step is to compare them with the literature. Based on the literature, the role of each profession in improving the competitive market for Indonesian herbs is to support the herbs by cultivating them, educating the societies, and do collaboration between Academics, Community, Business, and Government [9].

The important steps in herbal product development are first to generate and screen the new ideas (from staff, customers, and others), technical, market, and financial feasibility (to screen the idea), understanding the target market, selecting the most potential idea for a new

product, market and business analysis [10]. While based on [11], the important steps in herbal product development are formal legal aspects, technical and technological aspects, market and marketing aspects, human resource aspects, and economic aspects. While the need for empirical data or scientific data before new research on herbs, there is a paper that stated that even if there is empirical evidence of the application, there still needs to be scientific research to support it [12].

There is a paper from [13] telling that lemongrass and ginger itself have the potency for anti-diabetic activity, and there also a study of lemongrass and ginger product as ready to drink in SGU where it shows it is potential to make a product with both products that resulted in additive effects for maltose inhibitory activity[14] but the one that needs to be considered is how to prolong the shelf life of the product, the packaging of the products and also the marketing analysis (would it have a long life cycle or not in the market).

For now, herbal products cannot be sold in hospitals because there is still a lack of political will from stakeholders and no sufficient standard yet for the Formulary of Traditional Medicine. However, when it can be guaranteed by insurance, there is still a need for ministerial regulations to provide services with traditional medicine [15].

In comparison, there is no big difference between in-depth interviews, and based on literature, overall they both interview and literature are similar because the interview sources learn not only practically or based on experience but also based on literature too.

## **4. CONCLUSION**

This study found that empirical data and research is needed, academic and business have different important steps in developing herbal products, there is always a potential in commercializing anti-diabetic products and the prospects for herbal products will keep increasing. Additionally the strategy that can be suggested includes more research on lemongrass or ginger as anti-diabetic products because different places and regions it was taken have different activity, efficacy and safety. Also correct determination of product, claim and also think of a long life cycle product. Consideration also required in creating and mixing a product and also have an entrepreneurial thinking

## **ACKNOWLEDGMENTS**

First and foremost, I would like to thank God Almighty for His kindness and blessings so that I could finish my thesis work completely, despite the current challenges and situations happening at the moment. Furthermore, I would also like to express my deepest



gratitude to my family, for their continuous support, encouragement, and motivation.

My sincerest gratitude to Ms. Maria Gunawan Puteri as my thesis advisor and Mr. Victor Sahat Ringoringo for their patient guidance, encouragement, great advice, and support in this thesis. Also to all my friends, who were directly and indirectly involved in helping me to complete this thesis work.

## REFERENCES

- [1] W. Kerner and J. Brückel, "Definition, classification and diagnosis of diabetes mellitus," *Exp. Clin. Endocrinol. diabetes*, vol. 122, no. 07, pp. 384–386, 2014.
- [2] T. Ligita, K. Wicking, K. Francis, N. Harvey, and I. Nurjannah, "How people living with diabetes in Indonesia learn about their disease: A grounded theory study," *PLoS One*, vol. 14, no. 2, p. e0212019, 2019.
- [3] R. Amelia, "The Model of Self Care Behaviour and the Relationship with Quality Of Life, Metabolic Control and Lipid Control of Type 2 Diabetes Mellitus Patients in Binjai City, Indonesia," *Open access Maced. J. Med. Sci.*, vol. 6, no. 9, p. 1762, 2018.
- [4] R. Widyawati and M. Agil, "Natural Products Chemistry of Global Tropical and Subtropical Plants Chemical Constituents and Bioactivities of Several Indonesian Plants Typically Used in Jamu," vol. 66, no. 5, pp. 506–518, 2018.
- [5] BPOM, "PEDOMAN KLAIM KHASIAT OBAT TRADISIONAL," 2018.
- [6] D. Widiputri, N. Mariana, B. Josopandojo, M. Gunawan-Puteri, and I. Kartawiria, "Effect of pre-treatment processes and stability testing of lemongrass (*Cymbopogon citratus*) extract on  $\alpha$ -glucosidase inhibitor (AGI) and  $\alpha$ -amylase inhibitor (AAI) activities," *MSU Editor. Board*, p. 10, 2017.
- [7] A. S. P. Pereira, A. J. Banegas-luna, J. Peña-garc, P. Horacio, and Z. Apostolides, "Evaluation of the Anti-Diabetic Activity of Some Common Herbs and Spices : Providing New Insights with Inverse Virtual Screening," 2019.
- [8] Z. Salim and E. Munadi, "Info Komoditi Tanaman Obat. Badan Pengkajian dan Pengembangan Perdagangan Kementerian Perdagangan Republik Indonesia," 2017.
- [9] A. Suyitno and N. Aisyah, "Developing Nusanatara Green Pharmacy village (NGPVill) Through Herbal Technoprenurship Program in Indonesia," *1st Annu. Int. Sch. Conf. Taiwan.*, no. April, pp. 183–194, 2013.
- [10] E. Harnvanich, S. Wanichwecharungruang, A. Chandrachai, and P. Asawanoda, "Market Potential Evaluation for Local Herbal Extracts Used in Skincare Through the New Product Development Process," *PSAKU Int. J. Interdiscip. ...*, vol. 9, no. 2, pp. 31–40, 2020, [Online]. Available: <https://so05.tci-thaijo.org/index.php/PSAKUIJIR/article/view/248293>.
- [11] G. Handiwibowo, Lissa Rosdiana Noer, Reny Nadlifatin, Gita Widi Bhawika, Choirul Mahfud, and Arman Hakim Nasution, "Feasibility Study Pusat Herbal Dan Teknologi Park Berbasis Circular Economy Di Kota Batu," *JURPIKAT (Jurnal Pengabd. Kpd. Masyarakat)*, vol. 1, no. 3, pp. 262–274, 2020, doi: 10.37339/jurpikat.v1i3.347.
- [12] Y. Li *et al.*, "Traditional Chinese medicine for treating novel coronavirus (2019-nCoV) pneumonia: protocol for a systematic review and meta-analysis," pp. 1–6, 2020, doi: 10.21203/rs.2.23447/v1.
- [13] K. Kochar Kaur, "Bioactive Compounds within Herbs and Spices Contributing to Anti Diabetic Action in Type2 Diabetes Mellitus (T2DM) - A Short Communication," *Acta Sci. Nutr. Heal.*, vol. 4, no. 1, pp. 88–92, 2019, doi: 10.31080/asnh.2020.04.bioactive-compounds-within-herbs-and-spices-contributing-to-anti-diabetic-action-in-type2-diabetes-mellitus-t2dm-a-short-communication.
- [14] F. Santoso, J. Sunardi, F. Ignatia, and M. D. P. T. Gunawan-Puteri, "The Impacts of Formulation and Storage on alpha-glucosidase inhibitory activity of lemongrass, ginger, and blacktea functional beverages," *J. Farm. Sains dan Komunitas*, vol. 18, no. 1, pp. 26–38, 2021.
- [15] L. Widowati, O. Dwi Sampurno, H. Siswoyo, R. Sasanti, Nurhayati, and Delima, "Kajian Kebijakan Pemanfaatan Obat Tradisional Di Fasilitas Pelayanan Kesehatan Pada Era Jaminan Kesehatan Nasional," *Bul. Penelit. Sist. Kesehat.*, vol. 23, no. 4, pp. 246–255, 2020, [Online]. Available: <https://doi.org/10.22435/hsr.v23i4.3379>.