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The Effect of Ginger Candy (*Zingiber Officinale Rosc.*) on PGF2α Levels in Adolescents with Primary Dysmenorrhea

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A B S T R A C T

Primary dysmenorrhoea is a common complaint that is commonly experienced by women around the world, especially teenagers. One of the causes of primary dysmenorrhea is the hyperactivity of the myometrium which is modulated by the synthesis of prostaglandins, especially PGF2α. Some herbs are known to work as prostaglandin inhibitors, one of them are ginger. Giving ginger in adolescents who experience dysmenorrhea is expected to lower the levels of PGF2α so that dysmenorrhea pain can be reduced. Generally ginger can be developed in a variety of food and beverage products such as jelly candy. The purpose of this study was to analyze the effect of ginger candy to decrease the levelof PGF2α in adolescents with primary dysmenorrhoea. This research is an analytic research which used randomize pre post group design experimental approach. The object of the research is 38 adolescents with primary dysmenorrhoea. The object is divided into two groups, 19 treatment group and 19 control group. The treatment group was given jelly candy containing 100 mg of ginger extract, while the control group was given jelly candy without ginger. The candy was given on the first day of menstruation until the second day of menstruation. The measurement of PGF2α level was on the second day of menstruation after the candy was given to the groups. The results showed that after administration of candy, the last average levels of PGF2α in the treatment group decreased from 482,9 ng/ml to 370,5 ng,ml or down by 11%. Whereas in the control group,the PGF2α level 483,3 become 409,2. The difference in the percentage of decreasing in the levels of PGF2α using mann whitney test showed significant result (ρ=0,002). The conclusion of this research is ginger candy can reduce levels of PGF2α in adolescents with primary dysmenorrhoea.

Kata kunci:

PGF2α
Dismenorea Primer
Permen Jeli Jahe

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A B S T R A K

Dismenorea primer merupakan keluhan umum yang biasa dialami oleh wanita di seluruh dunia terutama remaja. Salah satu penyebab terjadinya dismenorea primer adalah hiperaktivitas miometrium yang dimodulasi oleh sintesis prostaglandin, terutama PGF2α. Beberapa herbal diketahui dapat bekerja sebagai prostaglandin *inhibitors*, salah satunya jahe. Pemberian jahe pada remaja yang mengalami dismenorea diharapkan akan menurunkan kadar PGF2α sehingga nyeri dismenorea yang dirasakan akan berkurang. Secara umum jahe bisa dikembangkan dalam berbagai produk makanan salah satunya permen. Tujuan penelitian ini adalah untuk menganalisa pengaruh pemberian permen jahe terhadap penurunan kadar PGF2α pada remaja yang mengalami dismenorea primer. Penelitian ini merupakan penelitian analitik dengan pendekatan eksperimental *randomize pre post group design*. Objek penelitian berjumlah 38 orang remaja yang mengalami dismenorea primer, objek dibagi menjadi 2 kelompok, yaitu 19 kelompok perlakuan dan 19 kelompok kontrol. Pada

kelompok perlakuan diberikan permen jeli yang mengandung 100 mg ekstrak jahe, sedangkan pada kelompok kontrol diberikan permen jeli tanpa kandungan jahe. Pemberian permen dilakukan pada hari pertama menstruasi sampai hari ke dua menstruasi. Untuk pengukuran kadar PGF2α dilakukan pada hari ke 2 menstruasi setelah pemberian permen. Hasil penelitian menunjukan bahwa setelah pemberian permen, rerata kadar PGF2α pada kelompok perlakuan turun dari 482,9 ng/ml menjadi 370,5 ng/ml atau turun sebesar 11,5%, sedangkan pada kelompok kontrol dari 483,3 ng/ml menjadi 490,2 ng/ml. Perbedaan presentase penurunan kadar PGF2α pada kedua kelompok penelitian dengan menggunakan uji *Mann Whitney* menunjukan hasil yang bermakna (ρ=0,002). Simpulan dalam penelitian ini adalah permen jahe dapat menurunkan kadar PGF2α pada remaja yang mengalami dismenorea primer.

INTRODUCTION

Dysmenorrhea is pain associated with the menstrual process, and is a common gynecological complaint in women of reproductive age. (Proctor & Murphy, 2001), (Bettendorf, Shay, & Tu, 2008), (Wallace, Keightley, & Gie, 2010) Dysmenorrhea can be divided into two types, namely primary and secondary. Primary dysmenorrhea is a pain during normal menstruation and is not associated with any pathological conditions (MY., 2006), (Lindeque BG, 2015) while secondary dysmenorrhea is a menstrual pain due to pathological conditions. (Wallace et al., 2010), (Lindeque BG, 2015).

Primary dysmenorrhea is a common complaint experienced by women all over the world, especially teenagers. In a study, it was reported that almost 90% of adolescents experienced dysmenorrhea and more than 50% of adult women also reported experiencing it, 10-20% of them complained of being very suffering and anxious about their condition. (Berkley, 2013) The data of dysmenorrhea case and the impact of dysmenorrhea on daily activities days on adolescents in Indonesia it self is not definite. In a preliminary study conducted at AISYAH Pringsewu University Lampung on 61 nursing students, it was found that 58 people or 95% experienced dysmenorrhea, using the VAS (Visual Analog Scale) scale for pain measurement, the results were obtained; 22% experienced mild pain, 47% moderate pain, 29% severe pain and 2% severe pain.

Primary dysmenorrhea is not a life-threatening disease, but dysmenorrhea pain can have an impact on a person's quality of life, even in severe conditions that will affect daily activities,being absent from school or work, mental and psychological disturbances, and even the choice of the desired type of baby delivery. (Liu et al., 2013) A study reported that dysmenorrhea is the reason for 34-50% of adolescent girls to be absent from school. (Mahvash et al., 2012).

One of the causes of primary dysmenorrhea is an increase in uterine prostaglandins derived from cyclooxygenase (COX)-2. The COX enzyme consists of 2 iso-enzymes, namely COX-1 and COX-2. COX-1 enzyme is constitutive to maintain normal physiology and homeostasis, while COX-2 is an enzyme that is induced in inflamed cells by cytokines, endotoxins, and growth factors (Zukhrullah & Aswad, 2012) COX-1 is found in most tissues that functions to catalyze prostaglandin E-2 (PGE-2) which has a cytoprotective function and helps in maintaining the integrity of the gastrointestinal mucosa. While COX-2 is induced by pro-inflammatory cytokines and produces prostaglandins (PGF2α) which mediate the inflammatory response, vasoconstriction (reduced oxygen flow), ischemia and the onset of pain. (Connolly, 2003) Clinical evidence also shows that women with severe dysmenorrhea have PGF2α. (Sriyakul, Kietinun, Pattaraarchachai, & Ruang rungsi) If excessive amounts of prostaglandins are released into the bloodstream, systemic effects such as diarrhea, nausea, vomiting will occur (MY., 2006).

The use of prostaglandin inhibitors, NSAIDs (Non Steroidal Anti-Inflammatory Drugs), and birth control pills are commonly used to treat dysmenorrhea, but are not recommended for routine use because there are concerns about side effects, namely stomach irritation (with symptoms of chest pain, nausea and vomiting), headache, and fluid retention. In addition, the use of birth control pills in unmarried adolescents is less accepted by culture in society. (Proctor & Murphy, 2001), (MY., 2006). There fore, it is very important to find a new type of therapy that is simpler and more acceptable by society for management of dysmenorrhea in adolescents.

Traditional medicine to reduce dysmenorrhea has been passed down from generation to generation by the people of Indonesia. In a preliminary study conducted by researchers, several teenagers used herbal medicine to reduce the pain of dysmenorrhea they felt. The traditional medicine itself according to Law No. 36/2009 concerning Health covers ingredients or potions in the form of plant ingredients, animal ingredients, mineral ingredients, preparations of extracts or mixtures of these ingredients which have been used for generations for treatment. In accordance with Article 100 paragraphs (1) and (2), sources of traditional medicines that have been proven to be efficacious and safe to use will be preserved and guaranteed by the Government for the development and maintenance of their raw materials. (Gunawan, 2015).

Some herbal spices are known to be effective for treating dysmenorrhea pain and other symptoms that accompany dysmenorrhea. Several compounds in herbs have anti-spasmodic and prostaglandin inhibitor effects, one of which is ginger (Zingiber officinale Rosc.) (Mirabia, Alamolhodab, Esmaeilzadeha, & Mojabc, 2013), (Terry, Posadzki, Watson, & Ernst, 2011).

The use of ginger for dysmenorrhea therapy is widely practiced. The compounds contained in ginger can inhibit the cyclooxygenase (COX) pathway in the process of

prostaglandin synthesis (van Breemen, Tao, & Li, 2011), (Chrubasik, Pittler, & Roufogalis, 2005) There fore, ginger can reduce prostaglandin levels that cause hyperactivity myometrium causing uterine ischemia causing pain. In an RCT (randomized clinical trial) study of 150 adolescents, it was stated that there was a significant difference in pain levels between the groups which were given ginger and those which were given a placebo. (Rahnama, Montazeri, Huseini, Kianbakhta, & Naseri, 2012) Another study that compared the use of ginger, tamarind mefemanat, and ibuprofen for the treatment of dysmenorrhea in 150 students found that ginger was as effective as mefemanic acid and ibuprofen for relieving dysmenorrhoea pain. (Ozgoli, Goli, & Moattar, 2009).

Ginger has anti-inflammatory properties. The main compounds of ginger that are anti-inflammatory are gingerol and zingerone, but in vivo almost all components of ginger have anti-inflammatory effects. Ginger works by influencing the modulation of leukotrienes and prostaglandin synthesis. (Lakhan, Ford, & Tepper, 2015) In one study, the administration of [6] gingerol (25 mg-50 mg/kg) intraperitoneally could inhibit inflammation in the paws of animals that were given carrageenan. (Singh, Duggal, Singh, & Katekhaye, 2010) It is well known that excessive production of prostaglandins (especially PGF2) will stimulate abnormal myometrial contractions which will reduce blood flow to myometrial cells, causing pain. (MY., 2006).

In some literature it is stated that the use of ginger dosage for the treatment of dysmenorrhea is 1000-2000 mg with variations in the administration of 2x per day, 3x per day, and 4 times per day, and in the form of a powder or capsule. (Lakhan et al., 2015) Other dosage forms that are simpler and more acceptable by the public, such as in the form of candy, or biscuits, have not been found in many literature studies. In general, ginger can be developed in various food and beverage products. Domestic products made from ginger include dried ginger, ginger candy, ginger powder, ginger oil and oleoresin. (Supriadi, Yusron, & Wahyudi, 2011).

In a preliminary study conducted by researc hers nationally on adolescents in several provinces to find out which form of processed ginger was preferred by adolescents, it was found that adolescents preferred processed ginger in the form of candy preparations.

METHOD

The research subjects were 38 Diploma 3 Midwifery students at Aisyah Pringsewu University who experienced dysmenorrhea. subjects will be divided into 2 groups. 19 people in the control group and 19 in the treatment group, who met the inclusion criteria and were willing to become respondents by signing the consent form after the explanation.

The research sample was taken by simple random sampling. Inclusion criteria were patients with primary menstrual pain aged 18-21 years, no organic abnormalities were found through ultrasound examination, experienced menstrual pain on a VAS scale of 4-6, had never been married and gave birth, had regular menstrual cycles for the last 3 months (28-30 days), and volunteered to participate in this study.

The exclusion criteria in this study were adolescents who had other complaints in the uterus and pelvis, adolescents who were undergoing treatment with painkillers, adolescents who had undergone surgery on the abdomen and pelvis, and adolescents who used contraceptives and other drugs.

The process of this research is to give ginger jelly candy and jelly candy without ginger for 2 days, namely the first day and the second day of menstruation to adolescents who are menstruating and experiencing primary dysmenorrhea. The dose used in this study was 100 mg of ginger extract which was made in 1 package of 6 pieces of candy which was given twice a day with 3 pieces of candy per serving. Subsequently, blood samples were taken to measure PGF2α levels. The data were collected directly by the researcher. Data collecting was conducted by using questionnaires, checklists and blood collection. PGF2α examination was carried out in the Molecular Genetics Laboratory, Faculty of Medicine, Unpad, using the ELISA method. The data collected were analyzed descriptively and analytically to analyze the effect of ginger candy on decreasing PGF2α levels.

The design used in this research is true experimental. The approach used in this study was a randomized pretest-posttest group design. Data analysis used Wilcoxon test and Mann-Whitney test.

RESULTS

Table 1
Characteristics of Subjects in Both Research Groups

Characteristic	Group		p
	Treatment (n=19)	Control (n=19)	
Age (year)			
x (SD)	19,0(1,20)	19,0(0,88)	0,795*
Median	19,0	19,0	
Range	18-21	18-21	
Menarche			
x (SD)	12,2(0,78)	13,3(0,94)	0,001*
Median	12,0	13,0	
Range	11-13	11-15	
Weight			
x (SD)	51,6(7,49)	58,0(25,25)	0,644*
Median	50,0	50,0	
Range	40-66	43-157	
Height			
x (SD)	156,(4,54)	146,9(30,41)	0,644*

Median	157,0	156,0	
Range	150-165	59-169	
PGF2α			
x (SD)	482,9(509,76)	483,3(443,51)	0,506*
Median	378,9	347,2	
Range	293,47-2543,08	253,16-2215,06	

*test used: Mann Whitney**

Based on the table. 1 In this study, the characteristics of the research subjects were equal between the control and treatment groups, including in terms of age, height, weight, and PGF2α levels.

Table 2
Differences in PGF2α Levels Before and After Dysmenorrhea Adolescents Given Ginger Candy

Description	Group					
	Treatment (n=27)			Control (n= 27)		
	Pre test	*Post test*	Score ρ	*Pre test*	*Post test*	ρ
PGF2α level						
x (SD)	482,9(509,76)	370,5(190,34)		483,3(443,51)	490,2(433,6)	
Median	378,9	308,41	0,002*	347,2	334,8	0,601*
Range	293,47-2543,08	253,16-1090,76		253,16-2215,06	302,9-2153,3	
△ **PGF2α level**						
x (SD)	112,3((327,81)			6,9(42,62)		0,003**
Median	-23,79			2,9		
Range	-1452,32 – 35,27			-61,76 – 94,02		
PGF2α percentage						
x (SD)	11,5 (15,11)			2,6(12,20)		
Median	-7,34			0,67		0,002**
Range	-57,11 – 10,33			-14,55- 34,83		

Test used: Wilcoxon, Mann Whitney***

DISCUSSION

Ginger is a type of herb that has many benefits, cheap and relatively safe to use. One systemic review reported that subjectively ginger can be used for pain relief in certain conditions, one of which is dysmenorrhea. (Terry et al., 2011)

In a randomized clinical trial (RCT) study of 150 adolescents, it was stated that there was a significant difference in pain levels between the groups that were given ginger and those who were given a placebo. (Rahnama et al., 2012) The use of ginger for dysmenorrhoea therapy is widely practiced. Compounds contained in ginger such as gingerol, shogaol and their derivatives can inhibit the cyclooxygenase (COX) pathway in the process of prostaglandin synthesis, (van Breemen et al., 2011). In addition, they can also inhibit the synthesis of pro-inflammatory cytokines such as IL-1, TNF- , and IL-8. (Mashhadi et al., 2013) There fore, ginger can reduce prostaglandin levels which cause myometrial hyperactivity which results in uterine ischemia causing pain.

Table 2 shows that at the beginning of the study the mean of serum PGF2α level in the treatment group was higher (378.9 ng/ml) than the control group (347.2 ng/ml), but statistically there was no significant difference between the control and treatment groups. This shows that the initial serum PGF2α level before candy administration was homogeneous. This condition is probably due to the fact that the research respondents have almost the same characteristics. Meanwhile, at the end of the study, the mean of serum PGF2α level in the treatment group was lower (308.41 ng/ml) than the control group (334.8 ng/ml). This average value indicates the success of giving ginger candy to reduce PGF2α levels. This table also shows that in the treatment group there was a significant decrease in PGF2α levels before and after the study (ρ=0.002) and the decrease in PGF2α levels in the group given ginger candy therapy was greater than in the group given candy without ginger (ρ<0.05).

Giving ginger to reduce pain has been mentioned in several studies. Research by Amritpal Singh et al 2010 on experimental pharmacology for gingerol compounds and their derivatives showed that ginger is considered to have an anti-inflammatory effect because it inhibits cyclooxygenase and 5-lipoxygenase, thereby reducing the synthesis of prostaglandins and leukotrienes. (Singh et al., 2010) Research by Richard et al. about Cyclooxygenase-2 inhibitors in ginger also show the results that by using liquid chromatography-tandem mass spectrometry (LC-MSMS) compounds 10-gingerol, 8-shogaol, and 10 shogaol are compounds in ginger that may be responsible for the anti-inflammatory process by inhibiting COX-1 and COX-2. (van Breemen et al., 2011)

The existence of a correlation between prostaglandins and menstrual pain is supported by the research of Fortier et al., in their research it was found that prostaglandins and leukotrienes cause an inflammatory response, which will cause uterine muscle spasm and systemic complaints such as nausea, vomiting, flatulence and headaches. (Fortier, Krishnaswamy, Danyod)., Boucher-Kovalik, & Chapdalaine, 2008). A study conducted by Dawood and Khan-Dawood, by measuring the levels of PGF2α in menstrual blood contained in tampons, it was found that PGF2α levels were twice as high in women who experienced menstrual pain compared to those who experienced no menstrual pain. Giving ginger to adolescents who experience dysmenorrhea is expected to reduce PGF2α levels so that the perceived dysmenorrheal pain will be reduced. (MY., 2006), (Ozgoli et al., 2009)

Based on the table, it is observed that there are respondents who experience a decrease in PGF2α levels in

the control group and conversely there is an increase in PGF2α levels in the treatment group. Many factors can influence this, including hormone levels, nutritional status, stress, and physiological conditions of the body, sports activities and diet. (Mayo, 1997) Besides that, humans are unique individuals and have different biological characteristics so that their response to stimuli are also different.

During the luteal phase, there is excessive production of endometrial prostaglandins. Prostaglandins (especially PGE2 and PGF2α) diffuse into the endometrial tissue which then stimulates abnormal uterine/myometrial muscle contractions, this excessive contraction will reduce blood flow resulting in ischemia in myometrial cells resulting in spasmodic pain. PGF2α levels are highest in the first 2 days of the menstrual period. (GUIDELINE, 2005)

Based on the explanation above, it can be concluded that there is an effect of giving ginger jelly candy to the decreasing of serum PGF2α levels in adolescents with primary dysmenorrheal.

CONCLUSION

In the ginger candy group there was a decreasing of PGF2α levels before and after the study and the decreasing of PGF2α levels in the group which was given ginger candy therapy was greater than in the group which was given candy without ginger.

REFERENCES

Proctor M, Murphy PA. Herbal and dietary therapies for primary and secondary dysmenorrhoea. The Cochrane Library. 2001. https://pubmed.ncbi.nlm.nih.gov/11687013/

Bettendorf B, Shay S, Tu F. Dysmenorrhea: contemporary perspectives. Obstetrical & gynecological survey. 2008;63(9):597-603. https://pubmed.ncbi.nlm.nih.gov/18713479/

Wallace S, Keightley A, Gie C. Dysmenorrhoea. The Obstetrician & Gynaecologist. 2010;12(3):149-54. https://obgyn.onlinelibrary.wiley.com/doi/pdf/10.1576/toag.12.3.149.27596

MY. D. Primary dysmenorrhea: Advances in pathogenesis and management. Obstet Gynecol. 2006;108:428–41. https://pubmed.ncbi.nlm.nih.gov/16880317/

Lindeque BG. Dysmenorrhoea. South African Family Practice. 2015;57(2):6-9. https://www.ajol.info/index.php/safp/article/view/160497

Berkley KJ. Primary dysmenorrhea: an urgent mandate. Pain. 2013;1:1-8. https://www.iasp-pain.org/PublicationsNews/NewsletterIssue.aspx?ItemNumber=2062

Liu P, Duan J, Wang P, Qian D, Guo J, Shang E, et al. Biomarkers of primary dysmenorrhea and herbal formula intervention: an exploratory metabonomics study of blood plasma and urine. Molecular Bio Systems. 2013;9 (1) :77-87. https://pubmed.ncbi.nlm.nih.gov/23111557/

Mahvash N, Eidy A, Mehdi K, Zahra MT, Mani M, Shahla H. The effect of physical activity on primary dysmenorrhea of female university students. World Applied Sciences Journal. 2012;17(10):1246-52. https://www.semanticscholar.org/paper/The-Effect-of-Physical-Activity-on-Primary-of-Mahvash-Eidy/4fcc112b2a236c5275f76a762aa2f3633c9530a6

Zukhrullah M, Aswad M. Kajian beberapa senyawa antiinflamasi: docking terhadap siklooksigenase-2 secara in silico. Majalah Farmasi dan Farmakologi. 2012;16(1). https://docplayer.info/60097304-Kajian-beberapa-senyawa-antiinflamasi-docking-terhadap-siklooksigenase-2-secara-in-silico.html

Connolly TP. Cyclooxygenase-2 inhibitors in gynecologic practice. Clinical medicine & research. 2003;1(2):105-10. http://www.clinmedres.org/content/1/2/105.full

Sriyakul K, Kietinun S, Pattaraarchachai J, Ruangrungsi N. A comparative double-blinded randomized study: *The efficacy of prasaplai herbal extract versus mefenamic acid in relieving pain among primary dysmenorrhea patients.https://www.researchgate.net/publication/286493672_A_Comparative_Double-Blinded_Randomized_Study_The_Efficacy_of_Prasaplai_Herbal_Extract_Versus_Mefenamic_Acid_in_Relieving_Pain_Among_Primary_Dysmenorrhea_Patients*

Gunawan W. Bioprospeksi: Upaya pemanfaatan tumbuhan obat secara berkelanjutan di kawasan konservasi. Kementerian Lingkungan Hidup. 2015.https://www.forda-mof.org/files/3_Bioprospecting_Upaya_Pemanfaatan_Tumbuhan_Obat-Wawan_Gunawan.pdf

Mirabia P, Alamolhodab SH, Esmaeilzadeha S, Mojabc F. Effect of Medicinal Herbs on Primary Dysmenorrhoea- a Systematic Review. Iranian Journal of Pharmaceutical Research. 2013;13(3):757-67. https://pubmed.ncbi.nlm.nih.gov/25276177/

Terry R, Posadzki P, Watson LK, Ernst E. The use of ginger (Zingiber officinale) for the treatment of pain: a systematic review of clinical trials. Pain Medicine. 2011;12(12):1808-18. https://pubmed.ncbi.nlm.nih.gov/22054010/

van Breemen RB, Tao Y, Li W. Cyclooxygenase-2 inhibitors in ginger (Zingiber officinale). Fitoterapia. 2011;82(1):38-43. https://pubmed.ncbi.nlm.nih.gov/20837112/

Chrubasik S, Pittler M, Roufogalis B. Zingiberis rhizoma: a comprehensive review on the ginger effect and efficacy profiles. Phytomedicine. 2005;12(9):684-701. https://pubmed.ncbi.nlm.nih.gov/16194058/

Rahnama P, Montazeri A, Huseini HF, Kianbakhta S, Naseri M. Effect of Zingiber officinale R. rhizomes (ginger) on pain relief in primarydysmenorrhea: a placebo randomized trial. BMC Complementary and Alternative Medicine. 2012:12-92. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3518208/

Ozgoli G, Goli M, Moattar F. Comparison of Effects of Ginger, Mefenamic Acid,and Ibuprofen on Pain in Women with Primary Dysmenorrhea. the journal of alternative and complementary medicine. 2009;15(2):129-32. https://pubmed.ncbi.nlm.nih.gov/19216660/

Lakhan SE, Ford CT, Tepper D. Zingiberaceae extracts for pain: a systematic review and meta-analysis. Nutrition journal. 2015;14(1):50. https://pubmed.ncbi.nlm.nih.gov/25972154/

Singh A, Duggal S, Singh J, Katekhaye S. Experimental advances in pharmacology of gingerol and analogues. Pharmacy Global: International Journal of Comprehensive Pharmacy. 2010;2(4). https://www.researchgate.net/publication/228468095_Experimental_advances_in_pharmacology_of_gingerol_and_analogues

Supriadi, yusron M, wahyudi D. bunga rampai : JAHE (*zingiber officinale Rosc.)* status teknologi hasil penelitian jahe.

Balittrolitbangdeptangoid. 2011. http://repository.pertanian.go.id/bitstream/handle/123456789/10028/Bunga%20Rampai%20Jahe%20(Zingiber%20officinale%20Rosc.)_Status%20Teknologi%20Hasil%20Penelitian%20Jahe.pdf?sequence=1