Antifungal Activity of Phyllosphere Actinobacteria against Pyricularia oryzae

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Abstract
Secondary metabolites produced by microbes provide many pharmaceutical agents such as antibacterial, antifungal, antiviral and immunosuppressant. Antifungal plays important role in inhibit the fungus which detrimental to agriculture and human health. The excess usage of antifungal inducing many fungus species to became resistant so that development of new antifungal is quite important. Actinobacteria are Gram positive bacteria which known to have produced 45% of the total metabolites produced by microbe and 70% of total metabolites produced by bacteria. As many as 33% of the metabolites produced by Streptomyces sp., including metabolites which have antifungal activity. Some phyllosphere actinobacteria are known to have potential antifungal activity. The purposes of this study were to screen rice phyllosphere actinobacteria that has antifungal activity against Pyricularia oryzae (Po) causes rice blast disease and to observe the responses of the hyphae of actinobacteria isolates in vitro. A total of eight isolates had antifungal activity against Po. STG 11 had identified as Streptomyces has the highest inhibitory activity that was 72.5%. The response of Po hyphae towards STG 11 indicate a disruption of growth direction of the hyphae which tend to form a curve. Two isolates had chitinolytic activity and six isolates had no hemolytic activity.

Key words: Actinobacteria, antifungal activity, chitinolytic activity, phyllosphere, Streptomyces

Introduction
Secondary metabolites produced by microbes are the main source of compounds with diverse chemical structures and potentially has a high biological activity (Arasu et al, 2008). Secondary metabolites produced by microbes provide many pharmaceutical agents such as antibacterial, antifungal, antiviral and immunosuppressant. Those low molecular weight compounds are not required for normal growth of microbes although they can be beneficial for its organisms. Bacteria, include a group of actinobacteria, produce some metabolites such as extracellular enzymes and any other various of secondary metabolites (Spadari et al, 2013). Antifungal plays important role in inhibit the fungus which detrimental to agriculture and human health. The escalating use of antifungal agents in long-term treatment strategies has raised the prevalence of fungus strains that are resistant to most commonly prescribed antifungal agents (Selmecki et al, 2009). Resistant strains find their way to hosts in three colonization and infection scenarios: (i) exposure to an initially susceptible strain that subsequently mutates and becomes resistant; (ii) exposure to a number of strains of which one is resistant and eventually is the only one to thrive, resisting the presence of antifungal drugs in the host organism; and (iii) exposure to an inherently resistant strain (Rex et al, 2008). Growing fungus resistances posses a considerable challenge to the pharmaceutical industry in the search for safe and efficient antifungal drugs (Dhanasekaran et al, 2008). High potency of actinobacteria in producing bioactive compounds make them very useful in order to find new medicines. Thousands of these compounds have been isolated, characterized, and some are used to treat human disease, animal disease, and also solve problems in agriculture (Arasu et al, 2008). It was reported that the number of secondary metabolites produced by microorganisms was about 23000 where 10000 of them produced by actinobacteria. In other words, actinobacteria produced 45% of total metabolites produced by microbes. A total of 7600 of them produced by Streptomyces sp. (Berdi, 2005). Actinobacteria is a group of bacteria that known as a gram positive promising antifungal source, for example, Urachimycins. Urachimycins is a class of antimycin which can inhibit electron transport in the respiration chain in mitochondria (Barrow et al, 1993). Antimycins obtained from Streptomyces isolated from integument of Attine ant (genus Acromyrmex) (Seipke et al,
Therefore, research for antifungal produced by actinobacteria from potential and unique source was needed. The previous study reported that cucumber phyllosphere actinobacteria produce antifungal activity. Its culture filtrate may inhibit the germination of pathogenic Corynespora cassicola (Wang & Ma, 2011). Research on the activity of secondary metabolites derived from rice phyllosphere actinobacteria has not been done. Ilsan et al (2016) reported that rice phyllosphere actinobacteria have antibacterial activity against Gram-negative bacteria Xanthomonas oryzae. Pyricularia oryzae (Po) is an important pathogenic fungi that causes rice blast disease. In this study, P. oryzae used as an initial model in the screening of antifungal produced by rice phyllosphere actinobacteria.

Method

Primary Screening: Inhibition Test of Actinobacteria against Po
Isolation of rice phyllosphere actinobacteria had done on previous research by Ilsan et al (2016). Inhibition test of actinobacteria against Po conducted using dual culture method (El-Tarabilya et al. 2000). Po isolates obtained from Department of Plant Protection, Faculty of Agriculture, IPB, courtesy of Dr. Abdjad Asih Nawangsih. Actinobacteria streaked on Potato Dextrose Agar (PDA) with a distance of 3 cm from Po colony. Po colony has taken using sterile pit diameter of 6 mm. The interaction between actinobacteria and Po observed after 7 days of incubation at 37°C. Percentage of inhibition calculated using the following formula:

\[
\% \text{ Inhibition} = \frac{B - A}{B} \times 100\%
\]

A is the length of Po hyphae grown with actinobacteria
B is the length of Po as a control

Secondary Screening: Inhibition Test of Actinobacteria against Po
Antagonistic activity of the supernatant of actinobacteria against Po tested using poisoning food method. Actinobacteria were cultured in 50 ml liquid medium of Yeast Malt (YM) and Modified Nutrient Glucose (MNG), incubated for 7 days on a shaker 150 rpm. The culture was centrifuged at 8880 x g for 20 minutes, the pellets were discarded and the supernatant was collected. Each 5 ml and 10 ml of the supernatant was mixed into 10 ml of sterile PDA that not solidified yet then poured into a petri dish. Furthermore, Po colony (diameter 6 cm) was place in the middle of the petri dish contains a mixture of PDA and supernatant. Percentage of growth inhibition of hyphae calculated using the following formula:

\[
\% \text{Inhibition of growth hyphae} = 100 - \frac{(r^2)}{(R^2)}
\]

R: radius of Po colony on PDA without actinobacteria supernatant (control)
r: radius of Po colony on PDA with actinobacteria supernatant

Inhibition activity was observed after 7 days of incubation (Boukaew & Prasertsan 2014). The growth of hyphae was observed using a light microscope at the magnification of 400x.

Test of Chitinolytic Activity
Actinobacteria were streaked on solid chitin media (3 g colloidal chitin, 1 g K2HPO4, 0.2 g MgSO4 7H2O, 1 g yeast extract, 20 g agarose and 1 L distilled water). Incubation was performed for 6 days at 37°C. Chitinolytic activity was showed by formation clear zone around Po colony that indicating the solubility of chitin by actinobacteria (Tahtamouni et al. 2006).
Test of Hemolytic Activity

Actinobacteria were streaked on blood agar medium (5% of sheep blood and 2.5% NaCl), then incubated for 3 days at 37°C. Hemolytic activity was showed by formation clear zone around actinobacteria colony. This formation of a clear zone indicates hemolytic activity by actinobacteria (Garcia-Bernal et al. 2015).

Results

Characteristics of Actinobacteria Which Have Inhibitory Activity Against Po

Seven actinobacteria isolates have inhibitory activity against Po, those are STG 2, STG 6, STG 8, STG 11, STG 13, STG 14 and STG 17 (Figure 1).

![Morphological diversity of rice phyllosphere actinobacteria colony age 10 days on solid Yeast Malt Extract media.](image)

**Fig 1.** Morphological diversity of rice phyllosphere actinobacteria colony age 10 days on solid Yeast Malt Extract media. (a) STG 2, (b) STG 6 (c) STG 8 (d) STG 11 (e) STG

Inhibition Activity of Rice Phyllosphere Actinobacteria Against Po

Seven isolates of actinobacteria could inhibit Po with percent inhibition range 17.5-72.5%. Secondary screening using the supernatant showed that seven isolates could inhibit Po. STG 6 showed the highest inhibition of hyphae that is 42.5% (Fig 2; Table 1). The Po that grown with STG 11 and STG 6 has disorder direction of hyphae which tends to form curve growth hyphae (Fig 3). Based on previous research (Ilsan et al. 2016), STG 11 is *Streptomycyes luteogriseus* with the similarity of 97% that had the highest antifungal activity. While STG 8 is *Actinomadura* sp. with the similarity of 97%. Identification of isolates was performed using 16S rRNA gene molecular approaches.

![Inhibitory activity of rice phyllosphere actinobacteria against Po using some method incubated for 7 days.](image)

**Fig 2.** Inhibitory activity of rice phyllosphere actinobacteria against Po using some method incubated for 7 days. (a) control Po, (b) method of dual culture, STG 8 isolate (c) poisoning media method STG 6 isolate
Figure 3. Response of growth of *Po* hyphae on antagonistic test towards rice phyllosphere actinobacteria using dual culture, observed under a light microscope at the magnification of 400x. (a) the growth of *Po* without rice phyllosphere actinobacteria; disruption of the direction of growth of the *Po* hyphae caused by the growth of (b) STG 6, and (c) STG 11.

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Dual Culture Inhibition (%)</th>
<th>Mycelial inhibition (%)</th>
<th>Food Poisoning</th>
<th>MNG broth 0.5 mL</th>
<th>1 mL</th>
<th>YM broth 0.5 mL</th>
<th>1 mL</th>
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<tbody>
<tr>
<td>STG 2</td>
<td>38.3</td>
<td>7.5</td>
<td>12.5</td>
<td>2.5</td>
<td>7.5</td>
<td></td>
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<tr>
<td>STG 6</td>
<td>55.0</td>
<td>0.0</td>
<td>42.5</td>
<td>2.5</td>
<td>7.5</td>
<td></td>
<td></td>
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<tr>
<td>STG 8</td>
<td>37.5</td>
<td>0.0</td>
<td>5.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
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<tr>
<td>STG 11</td>
<td>72.5</td>
<td>5.0</td>
<td>12.05</td>
<td>5.0</td>
<td>20.00</td>
<td></td>
<td></td>
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<tr>
<td>STG 13</td>
<td>30.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
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<tr>
<td>STG 14</td>
<td>45.0</td>
<td>2.5</td>
<td>2.5</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
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<tr>
<td>STG 17</td>
<td>50.0</td>
<td>7.5</td>
<td>5.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
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Chitinolytic activity of rice phyllosphere actinobacteria

Two isolates had chitinolytic activity i.e. STG 13 and STG 17 (Figure 4). Chitinolytic activity showed by the formation of a clear zone on the media colloidal chitin.

![Image](image.png)

**Fig. 4 Chitinolytic activity of rice phyllosphere actinobacteria (a) STG 13 and (b) STG 17. Hemolytic activity of rice phyllosphere actinobacteria on blood agar media. Negative hemolytic reaction isolate (c) STG 13; (d) positive hemolytic reactions isolate STG 17**

Hemolytic activity of phyllosphere actinobacteria

As many as one (STG 17) of seven isolates of phyllosphere actinobacteria had positive hemolytic activity. It can be said that six isolates are not potentially pathogenic actinobacteria in animals and humans. Positive hemolytic showed by the formation of the clear zone on blood agar medium (Figure 4).

Discussion

The development of secondary metabolites produced by microorganisms that have antagonistic activity now become important in order to find pharmaceutical agent and biocontrol of plant pathogens. In this study, STG 11 isolate as *S. luteogriseus* had the highest activity in inhibiting the growth of *P. oryzae* both in vitro and through cell culture supernatants. These results indicate that the isolates produce extracellular antifungal substance. The antifungal mechanism may through antibiosis, reduced nutrients around fungi, and hyperparasitism by releasing the cell wall degrading enzymes (i.e. glucanase and chitinase) (Harman et al, 2004; Bakker et al. 2007). It is known that *Streptomyces* widely used in pharmaceutical, agrochemical, industries, and mainly has great commercial value in the food industry (Burja et al, 2001; Vijayakumar et al. 2012).

Many studies have reported the inhibitory activity of actinobacteria against *P. oryzae* using dual culture method, it has inhibitory activity of 60.5%. This proves that STG 11 was better than NRP1-14 at inhibiting *Po* in vitro using the same method with % inhibitory up to 72.5%. However, this inhibition was slightly lower than Ferimzone, a new fungicide with biological properties, inhibited the mycelial growth of *Po* to 89% at 5-20 µg/ml (Gouramanis 1997). Ferimzone (methylacetophenone 4, 6-dimethyl-2-pyrimidinyl-hydrazone) did not affect the respiratory activity of mycelia of *Po*, it caused the leakage of some electrolytes from mycelia, which decreased the pH of the medium, suggesting that ferimzone disrupted membrane function (Okuno et al 1989). *Bacillus licheniformis* MML2501 has been known able to produce azole which antifungal that already used in worldwide (Maheswari, 2011). Azole is the antifungal that already used for human disease (Price et al, 2015) or plant pathogen (Sheehan et al, 1999).

Antifungal activity produced by actinobacteria can be viewed by observing the response of hyphae while treated by the isolates both in vitro and in vivo. In this study, the existence of STG 11 and STG 8 make *Po* hyphal growth inhibited. It causes the hyphae grow curved away from actinobacteria when compared to the control. This is similar to the effect caused by *Pseudomonas*
chloriraphis against Rosellina necatrix, fungi causing white rot disease on the root of avocado, it produces antifungal metabolites 2-hexyl, 5-propyl resorcinol (HPR) (Calderon et al, 2014). Chitinase is one enzyme that can inhibit the growth of fungi. Chitinase containing glycosyl hydrolases that able to catalyze the degradation of chitin into oligomers (chitoooligosaccharides) and monomer (N-acetylglucosamine) (Nopakarn et al, 2002). Chitin is the second most abundant polymer in living organisms that composed of beta 1-4-linked N acetylglucosamine (GlcNAc). Chitin found in many groups of microorganisms such as bacteria and fungi as well as contained in the plant and animals. Some isolates that able to inhibit Po invitro also has chitinolytic activity. The existence of a clear zone on colloidal chitin medium indicates that the isolates have the potential to produce chitinase. Other chitinases were studied to exhibit antifungal activities like inhibition of germ tube elongation, spore germination, hyphal tip and bursting of spore (Lin et al, 2009). An antifungal substance used for human purposes must be safe for humans. The hemolytic test was conducted to ensure isolates did not produce hemolysin which can lyse human red blood cells. Isolates that have hemolysin has potential as human and animal pathogens. The presence of clear zone on blood agar indicates isolates produced hemolysin (Hidayati et al, 2014).

Conclusion

A total of seven isolates of actinobacteria can inhibit Po with the percent inhibition ranged from 17.5-72.5% in the primary screening test. Secondary screening using the supernatant showed seven isolates that could inhibit the growth of Po hyphae. The Po that grown with STG 11 has disorder direction of hyphae which tends to form curve growth hyphae. Two isolates have chitinolytic activity and one of them have hemolytic activity.

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Literacy Education on Health in Building Environment Health Behaviour: Qualitative Study on Community of Desa Paku Haji, Kecamatan Ngamprah, Bandung Regency

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Abstract
Environment health as an effort of preventing could be done earlier by family or by community. One of the efforts is literacy education on health. This research is about literacy education on health in building environment health literacy. The aims are to find out forms of education on environment health literacy carried out by health officers or nurses; efforts carried out by PKK (family welfare education program) cadres in creating environment health behavior. It used qualitative method with case study approach. Technique of data collecting are interview and literature study, and use data from 5 informants. The research results indicate the health officers and nurses used education strategy that is changing behavior through health education or promotion, which was started by health information dissemination to village official and the community through socialization and education to local government officers then to the community. In addition, the PKK cadres act as communicators who disseminate information which they got from health officers, health guidebook and research reports. They also provide model for the community in protecting environment, so the community at Pakuhaji village can implement environment health behavior as well.

Key words: health literacy, environment health, education strategy, health promotion.

Introduction
Health is an important aspect of a person's quality of life. But not everyone can understand and practice the health care efforts, whereas if the public is widely aware of the importance of health care, it will help the disease prevention process, improve the quality of health and play an active role in every effort to conduct health care. Bill Number 36 Year 2009 on Health in Article 1 states that "Health is a healthy condition, physically, mentally, spiritually and socially that enables every person to live productively in socially and economically" (Kementrian Kesehatan 2009). So it is known that the condition of health is not only physical, mental, and social aspects, but also includes aspects of productivity economically and socially productivity.

In addition, in the Bill on Health mentioned in Article 52 also explained that the efforts of health prime services include promotive, preventive, curative, and rehabilitative aspects. But now health care in the eyes of the society is still centered on curative and rehabilitative actions, so it tends to lead to the paradigm of ill rather than a healthy paradigm. Health improvement can be pursued by health promotion activities as revitalization of health education. With the promotion of health, not only the process of community awareness or the provision and improvement of public knowledge about health, but also the effort for behavioral change.

Therefore, the effort to become a member of the society who are health information literate becomes the right of every citizen, as stated in the Law of the Republic of Indonesia no. 36 of 2009 on Health in Article 7 that states: Everyone is righted to receive information and education about a balanced and responsible health.

Guidelines for the Implementation of Local Health Promotion as stipulated in the Decree of the Minister of Health Number 1114 / Menkes / SK / VII / 2005 (Kesehatan 2007) which states that health promotion is an effort to improve the ability of the community through learning from, by, for, and with the community so that they can help themselves, developing community-sourced activities in accordance with local socio-cultural conditions and supported by health concerned public policies.

District of Ngamprah West Bandung regency has two Puskesmas (public health centers), namely Puskesmas Cimareme and Ngamprah. Of the five villages which are in the area of Puskesmas Cimareme, there is a village which categorized as underdeveloped village, that is
Pakuhaji. This Pakuhaji village was just formed in 2013 as an extension of the village of Tanimulya.

From the results of observations and focus group discussions (FGD) in Pakuhaji District Ngamprah, there is a phenomenon that people who do not have awareness about the importance of keeping healthy environment. This is reflected in the statement of one of the informants: "When I was sweeping the very dirty road in front of someone's home yard, instead of offering to help, the owner say why don't you sweep the entire house. In addition there are also residents who do not want to clean the ditch in front of his house, so it was clogged and when heavy rains came it was flooding."

The data mentioned above become the baseline to state that in the effort to improve the public health level, the community needs to be awakened of their awareness to behave of maintaining environmental health. In addition, they will understand that environmental health is one of preventive efforts that can be done early, both from the family environment and society at large.

This phenomenon encourages us to study the health literacy conducted in the Village Pakuhaji Ngamprah District West Bandung in building environmental health behavior. The purpose of this research is to find out:

1. Forms of health literacy education conducted by health officers
2. Efforts of PKK cadres of Desa Pakuhaji in building environmental health behavior

Method

The method used in this research is qualitative with case study approach, to reveal and describe in more detail the program of "maintaining atmosphere" as health promotion strategy. The case study approach is a suitable strategy when the subject of a question is concerned with how and why, if the researcher has little chance of controlling the events to be investigated and the focus of his research lies in contemporary phenomena in real life (Yin 2008).

As (Deddy Mulyana 2007) points out, the case study is a comprehensive description and explanation of various aspects of an individual, a group, an organization (community), a program, or a social situation. Then get the description of health literacy education with the building of environmental health behavior from phase "know" to phase "want to" conducted by Puskesmas Cimareme and Kader PKK Pakuhaji Village. The data collection techniques used in this study are observation, interviews with informants and documentation studies. In this research, the data collection is conducted purposively, that is with certain consideration. For example, the selected person is considered to know most about the strategy of health promotion program, especially related to the development of the maintaining atmosphere. Informants consist of: 1) Ibu Sri Sariningsih, health promoter of PKK Cimareme; 2) Ibu Inang, Pakuhaji Village Midwife; 3) Head of PKK Team of Desa Pakuhaji; 4) Mrs. Lilis and 5) Mrs. Engkar, PKK cadre of Pakuhaji Village.

Result

Pakuhaji Village Ngamprah District West Bandung Regency consists of 4 village areas, 12 RW and 41 RT, with livelihoods generally as farmers and traders. Awareness to maintain environmental health is still relatively low. Therefore, efforts should be made to ensure that the literate community of environmental health is reflected in the appropriate behavior. Handling environmental issues involves and demands the participation of all parties, either directly or indirectly. In this research focuses on the role of health officers and PKK cadres in an effort to improve the health quality of their citizens.

The World Health Organization WHO (Soekijo Notoatmodjo, 2014) classifies several strategies as concrete and positive efforts to achieve appropriate behavioral changes in health norms, namely: 1) Using force (enforcement); 2) using regulatory or regulatory powers, and 3) education. From the results of the observation, we saw that environmental health awareness activities conducted by health workers using education or health promotion, begins with the provision of health information, both in the form of socialization and counseling to village officials and citizens. In addition, village-level working groups and districts are assigned to handle health issues in each village or village, at least in the preventive or preventive phase. This can be done with the socialization of healthy and clean living to every family.

The results from the field is not surprising, because basically health workers are equipped with knowledge related to change community awareness from behavior that does not support
healthy living. One of them by health promotion activities as revitalization of health education. Health promotion activities, not only the process of community awareness or the provision and improvement of public knowledge about health, but also the effort for behavior change. World Health Organization (WHO) in Ottawa Charter 1986 cited by (Soekijo Notoatmodjo 2007) has formulated: "Health promotion is the process of enabling people to increase control over, and improve, their health. To reach a state of complete physical, mental, and social, well-being, an individual or group must be able to identify and realize aspirations, to satisfy needs, and to change or cope with environment."

(Soekijo Notoatmodjo 2007) mentions people who are able or independent in the health sector, have a good knowledge (health literacy), at least as follows:

1. Knowledge of disease, whether contagious or non-contagious. Knowledge of this disease includes: the name or type of disease, signs or symptoms of the disease, the cause of the disease, the mode of disease transmission, the prevention of disease, and the appropriate places of health care to seek healing (treatment)
2. Knowledge of nutrition and food to be consumed in order to stay healthy as a determinant of one's health. Knowledge about the nutrients that must be owned by the community, including nutritional needs for the body. In addition, the types of daily foods that contain the nutrients the body needs, both in quantity and in quality; Consequences or diseases caused by malnutrition and so on
3. Healthy housing and basic sanitation needed to support family or community health. This environmental health knowledge includes, among others: ventilation and house lighting, clean water resources, stool disposal and waste water disposal, garbage disposal and so on
4. Knowledge of the dangers of smoking, and other substances that may cause health problems or addiction i.e. drugs (narcotics and illegal drugs)

Health workers, including health promoters from PKK Cimareme and Pakuhaji Village Midwives in their duty to teach environmental health behavior in accordance with the mission of health promotion, namely: 1) empower individuals, families, and communities to live healthy; 2) foster an atmosphere or environment conducive to the creation of Healthy Clean Lifestyle (PHBS) in the community; 3) advocate for decision makers and policy makers. For the field of advocacy, the materials are usually consulted in advance with UPT Health Promotion in West Bandung District Health Office, because it related to the authority and communication organization.

Health promotion strategies through empowerment will be successful if supported by activities to create an atmosphere or a conducive environment. Establishment of atmosphere is an effort to create an atmosphere or social environment that encourages individuals, families, and communities to prevent illness and improve their health and create a healthy environment and play an active role in every effort to manage health.

In the implementation of health promotion strategies it needs to be strengthened by methods and media and appropriate and the availability of adequate human resources. The referred method here is the method of communication. Basically, empowerment, maintaining atmosphere, and advocacy in principle is the process of communication. It is therefore necessary to determine the appropriate method in the communication process. The choice of method should be done carefully with attention to the information packaging, the state of the receiver of information (sociodemography) and the context of communication.

Media or information facilities also need to be carefully selected according to the established method. It should also pay attention to the target or recipient of the information. If the recipient of the information can not read, for example, then the communication will not be effective if use media full of writing. Or if the recipient of information only has a very short time, it will not be effective if the poster is placed containing the sentence which is too long (Kemenkes, 2007).

In Minister of Health Decree No. 1114 / Menkes / SK / VII / 2005 on Guidelines for Implementation of Health Promotion in the Region(Kesehatan 2012) it is stated that: Health promotion is an effort to improve the ability of the community through learning from, by, for and with communities, so that they can help themselves, and develop community-based activities, in accordance with local socio-cultural conditions and supported by sound public policy. Self-help means people are able to deal with potential (threatening) health problems by preventing them, and addressing the health problems that have occurred by handling them effectively and efficiently. In other words, people are able to behave in a clean and healthy way in order to solve their health
problems, both suffered and potential (threatening) health problems independently (within certain limits).

As we know information and education about health can be obtained from sources of documents, people, institutions, objects or situations. By looking at the situation, such as scattered garbage and clogged sewers, Pakuhaji villagers can tell that a blocked ditch is caused by the amount of garbage collecting in the ditch. More specifically the knowledge of the causes of blocked sewer is referred to as health information literacy. Information literacy is an outcome of health education or health promotion. Definition of health literacy according to WHO which is cited by (Nutbeam 2006) is as follows: Health literacy represents the cognitive and social skills that determine the motivation and ability of people to gain access to, understand and use information in which promote and maintain good health. For that, Nutbeam mentions that health literacy means more than being able to read pamphlets and successfully make appointments. By improving people's access to health information and their capacity to use it effectively, health literacy is critical to empowerment. Information literacy of health is important for every citizen, therefore there needs to be a directed community empowerment and sustained government support. This is important in efforts to improve the quality of public health and achieve overall health, namely physical health, mental health, social health and health from the economic aspects.

This can be described in an outcome model for health promotion, as follows:

According (Soekijo Notoatmodjo, 2007) health behavior can be classified into 3 groups, namely:

1) Health maintenance behavior i.e. the behaviors or efforts of a person to maintain or keep health so as not to get sick and efforts to heal if got sick.

2) Searching and use behavior of health service system or facility, or often called health seeking behavior, that is effort or action of someone when suffering from illness and or accident.

3) Environmental health behavior is how a person responds to the environment, both
physical and socio-cultural environment and so on, so that the environment does not affect his health.

In article 6 of Law no. 36 Year 2009 (Kementrian Kesehatan 2009) it is stated that everyone has right to a healthy environment for the achievement of health degree. To be able to achieve good health status, the person must live healthy on a regular basis. To be able to live healthy conditions needed a clean and healthy environment. (Soekijo Notoatmodjo 2007) mentions environmental health practices such as defecating in latrines (toilet), disposing of garbage in trash, using clean water for bathing, washing, cooking and so on.

Behavior is a mutual result between various factors, namely internal factors and external factors that make human behavior become very complex and in a wide range. In the field of public health, especially health education, studying the behavior is important to provide socio psychological conditions in such a way that individuals or communities behave in accordance with the norms of healthy life.

Saparinah Sadli in (Soekijo Notoatmodjo 2007) describes the relationship of individuals with the social environment affect each other as follows:

**Interaction of Health Behavior**

![Fig. 2 Relationship Between Individuals and Social Environment](image)

Note:

a) Individual health behavior: attitudes and habits of individuals closely related to the environment
b) Family environment: the habits of each family member about health
c) The environment is limited: traditions, customs and beliefs of the people in connection with health
d) General environment: government policies on health, Health laws, health programs and so on.

Based on the figure 2 above, environmental health condition in Desa Pakuhaji needs to be identified its relation to behavioral problems affecting health problem, also needs to be identified the physical and social environment matters that influence behavior, health status and quality of life of person or society.

Referring to the function of puskesmas in the Decision Letter Number 128 / Menkes / SK / II / 2004 on Basic Policy of Public Health Center (Kesehatan 2007) it is stated that puskesmas is as a center of community empowerment. Puskesmas strives that individual parties, especially community leaders, families and communities, including the business community to have awareness, willingness, and ability to serve themselves and the community to live healthy, play an
active role in fighting for health interests including financing, and also participate in establishing, organizing and monitoring the implementation of health programs with taking into account the conditions and situations, especially the socio-cultural of the local community. Therefore, the Health Office empowers village cadres or community empowering cadres (KPM), the volunteers who have a concern for improving the quality of the surrounding neighborhood health. Administratively, cadres are chosen by the community themselves, usually due to certain skills. Their skills are, among others, being literate and active in the community. This is a form of community health efforts (UKBM) and its existence in the development of Cimareme Puskesmas.

As the definition of health cadres, according to (Mubarak, W, I & Chayatin 2009) are volunteers, elected, trusted, and coming from the local community, have participated in health cadre training as implementers, maintainers and developers of community activities in the effort of health development and community welfare. The cadres are trained by health workers at the Sub-district Level, in order to identify the underlying causes of health problems that may stem from behavioral / knowledge, social environment, physical environment, biological environment or access to health services. Training provided by health workers for cadres based on one of the health promotion missions: Increase community knowledge by doing counseling, education & training and strengthening human resources to raise awareness. The ability and willingness of people to live clean and healthy.

In health literacy education, efforts are made first to increase the knowledge of PKK cadres in access to the acquisition and utilization of information, efforts to disseminate health information and health promotion strategies as a means of education. In the end the line of health literacy education leads to improving the health quality of the residents of Sukahaji Village. The cadres are trying to take advantage of every opportunity in the village to give information about the importance of environmental health. In this case the PKK cadres play a role as facilitators such as through group counseling at posyandu, Dasa Wisma group meetings, social gathering, recitation, village meetings, home visits and others. In addition, PKK cadres gave an example to the community, as one informant explained: "I often make a schedule that says every Sunday morning is time to sweep the road around my house helped by my husband." This effort is an example of how to respond to the environment, especially the physical environment so that Villagers of Desa Pakuhaji can apply environmental health behavior.

Conclusion
The conclusion drew from the research is that health workers conduct educational strategies, namely behavior change through education or health promotion, began with the provision of health information, such as socialization and counseling to village officials and citizens. PKK cadres serve as facilitators who convey information they obtain from health workers, health education guide books, and training outcomes; and provide exemplary behavior to the community related to how to respond to the environment, especially the physical environment so that villagers of Pakuhaji village can apply the environment health behavior.

References


