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SPICES PLANT AS BIOINSECTICIDES FOR CONTROLLING MAIZE WEEVIL *SITOPHILUS ZEAMAIS* (MOSTCH)

Pemanfaatan Tanaman Rempah sebagai Pestisida Nabati untuk Penanggulangan Hama Kumbang Bubuk Jagung Sitophilus zeamais (Mostch)

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ABSTRACT

Indonesia has numerous and varied natural resources of spices plant which grow at almost all theregions. These plants can grow and adapt to the slightly diverse agroecological conditions and agroecosystems, from dry to wet. In general, the utilization of these plants by the community is still limited as ingredients and spices for culinary and flavoring instead of the potential of bioactive compounds contained therein. These resourcesare very useful and effective utilized asbioinsecticides to eradicate plant pests and diseases, as well as medicine for human. This paper discussed the benefits and efficacy of several spiceplants, namely lemongrass, shallots, garlic, sweet and chili peppers, clove, sand ginger (*kencur*), and pepper as herbicides at various levels of dosage and treatments. This manuscript also discussed the constraints and development strategies, and aimed to provide information on the science and technology in controlling the *Sitophilus zeamais* (Motsch.) pests in corn kernels during the storage period. It is expected that this paper would be useful for the policy makers, academicians, researchers and practitioners who have the competence to deal with beetle pest problems.

Keywords: Spices, bioinsecticides, *Sitophilus zeamais* (Motsch), controlling

ABSTRAK

berbagai agroekologi dan agroekosistem, mulai dari wilayah beriklim kering sampai beriklim basah. Pemanfaatan tanaman ini oleh masyarakat umumnya masih terbatas sebagai bahan rempah dan bumbu kuliner, penyedap masakan dan cita rasa, padahal senyawa bioaktif yang terkandung di dalamnya potensial sebagai pestisida nabati untuk membasmi hama penyakit tanaman dan bahan obat kesehatan manusia. Tulisan ini membahas manfaat dan kemanjuran dari beberapa tanaman rempah, yakni tanaman sereh, bawang merah, bawang putih, lombok merah, cengkeh, kencur, dan lada sebagai pestsisida nabati dalam berbagai dosis dan ragam perlakuan. Kendala dan strategi pengembangan pestisida nabati bagi penggulangan hama kumbang bubuk perlu mendapat perhatian yang tidak saja untuk kepentingan masyarakat luas, namun diperlukan sebagai informasi ilmu dan teknologi penanganan hama secara terpadu.

Kata kunci: *Tanaman rempah, bioinsektisida, hama kumbang bubuk, pengendalian*

INTRODUCTION

It is stated in Government Regulation No. 6 of 1995, concerning the Plant Protection Policy, chapter II article 19 that the use of synthetic insecticides to control plant pests and deseases should be chosen as the last effort in the context of controlling the Plant Disturbing Organisms (PDO) as well as the impact caused by the use of such synthetic chemical compounds as early as possible, so that it can be reduced as low as possible (Komara Share 2020). Therefore the policy of utilizing environmentally friendly plant bioinsecticides materials is the right choice to build the future of agriculture.

There are numerous and varied potentials and natural resources of germplasm of Indonesian spicesplants which are used as bioinsecticides which grow at almost all theregions. These plants can grow and adapt to slightly diverse agroecological conditions and agroecosystems, from dry to wet. In general, the utilization of these plants [illegible] ngredients and spices for culinary and flavoring instead of the potential of bioactive compounds contained therein which are very useful and effective tobe used asbioinsecticides to eradicate plant pests and diseases, as well as medicine for human (Saenong and Arrachman 2016; Saenong and Arrachman 2017).

As a tropical country, Indonesia has a very diverse flora which contains a number of types of plants as the sources of insecticide which can be used for pest control. Nowadays, there have been many researches conducted on plant families that have the potentials to be used as bioinsecticides from around the world. It is reported that there are more than 1,500 species of plants can have bad impact on insects (Kardinan and Ruhnayat 2003; Kardinan and Wikardi 1994; Herlina and Istiaji (2013). Reports from various provinces in Indonesia stated that there are more than 40 species of plants that also to be used as bioinsecticides. In addition, Prijono and Hasan (1995), Wiratno *et al.* (2011) also noted that, in Indonesia, there are 50 families of poison-producing plants. Plant families that are considered to be potential sources of bioinsecticides are *Meliaceae, Annonaceae, Asteraceae, Piperaceae* and *Rutaceae*, but this does not rule out the possibility of finding new plant families. There are many types of plants that have properties as bioinsecticides, thus, extracting the potential of plants as a source of bioinsecticides as an alternative to plant pest control is quite and prospective

Syakir (2011) defined that bioinsecticides are single active ingredients or compounds from plants that can be used to control plant-disturbing organisms, can function as repellents, teaser, antifertility and killers of plant-disturbing organisms. Furthermore, Haryono (2011) stated that bioinsecticides are pesticides with basic ingredients derived from plants, which can function as killers, repellents, binders or inhibitors of pest growth. Bioinsecticides are also defined as pesticides whose basic ingredients are from plants, and are relatively easy to make even with limited ability, and knowledge. Because it is made from natural or vegetable ingredients, this type of pesticide is biodegradable in nature, so it does not pollute the environment and is relatively safe for humans and domesticated animals, because the residue (residual substances) is easily eliminated.

Takahashi (1981), Aranillewa *et al.* (2006), and Babarinde *et al.* (2008) defines that bioinsecticides are natural ingredients containing bioactive compounds which can be classified into three, namely; (a) natural ingredients containing antipytopathogenic compounds (agricultural antibiotics), (b) natural ingredients containing phytotoxic compounds or regulating plant growth (phytotoxins, plant hormones and the like), and (c) natural ingredients containing active compounds against insects (insect hormones, pheromones, antifeedants, repellents, attractants and insecticides). The working mechanism of bioinsecticides protects plants from disturbing organisms, among others by inhibiting the reproduction process of insect pests, especially female insects, reducing appetite, rejecting food, damaging the development of eggs, larvae, and pupae so that the breeding of pest insects can be inhibited, and inhibiting skin turnover. Furthermore, the other mechanism is in the repellent group, which rejects the presence of insects, for example with a strong odor, antifeedant group, which prevents insects from eating sprayed plants, inhibits reproduction of female insects, acts as nerve poisons, disrupts the hormone system in insect bodies, attractant groups, which is as a lure for the presence of insects that can be used in trapping insects, and controlling the growth of fungi/bacteria and there are also groups of herbicides that have an effect on reducing insect preferences in accessing food sources (Bedjo 1993, Erliana 1991, García-Lara and Bergvinson 2007). This manuscript also discussed the constraints and development strategies, and aimed to provide information on the science and technology in controlling the *Sitophilus zeamais* (Motsch.) pests in corn kernels during the storage period. It is expected that this paper would be useful for the policy makers, academicians, researchers and practitioners who have the competence to deal with beetle pest problems.

SEVERAL POTENTIAL SPICES PLANTS WHICH ARE EFFECTIVE TO REDUCE THE ATTACK RATE OF *S. ZEAMAIS* (MOTSCH.)

In general, plants, especially for bioinsecticides and medicines, are rich in bioactive ingredients, although only about 10,000 types of secondary metabolite production have been identified, but actually the amount of chemicals in plants that have the potential as herbicidescan exceed 400,000 specie. Grainge *et al.* 1984 *in* Sastrosiswojo (2002) reported that there were 1,800 types of plants containing bioinsecticides which could be used for pest control. In Indonesia, there are a large number of plant species producing bioinsecticides, and estimated 2,400 plant species are included in 235 families (Kardinan 1999, Astriani 2010, Surtikanti 2004, Subiyakto 2009).

Lemongrass

Lemongrass belongs to a group of grasses called *Andropogon nardus* or *Cymbopogon nardus*. This genus covers almost 80 species, but only a few species produce essential oils which have economic meaning in the world of commerce. Lemongrass can grow up to 1-1.5 m. The leaves have a length reaching 70-80 cm and width of 2-5 cm, with light green color, rough texture and strong aroma (Hartati 2012).

Lemongrass contains essential oils of which compositions include citral, citronella, geraniol, myrcene, nerol, farnesol methylheptane and dipentene (Guenther 1990, Herminanto *et al.* 2010). The highest content is citronella which is equal to 35% and graniol ($C_{10}H_{18}O$) of 35-40%. Citronella has desiccant toxicity. The poison is a contact poison that can cause death due to continuous fluid loss. Insects affected by this poison will die from lack of fluids. In addition, the benefits of lemongrass leaves are also repellent, as well as insecticides, bactericides, nematicides.

Kadir *et al.* (2014) examined the effectiveness of lemongrass leaves (*Cymbopogon citratus* LRendle) as bioinsecticides in suppressing *Sitophilus* spp. in several insect jars. The study aimed to determine the effect of storage jars and the form of lemongrass on the percentage of pest mortality, the effectiveness of pesticides and the number of first derivatives of corn beetle pests. The results showed that the treatment of glass jars had a significant effect on the percentage of pest mortality of 51.66%, the percentage of effectiveness was 51% and the number of first descendants was 81 (Figure 1 and 2).

The research conducted by Astriani (2012) showed the following results: (a) vetiver and citronella grass with a dosage of 5-20% in the solution formulation (extract) had contact and feed toxicity to mostch pests on corn kernels, while in powder and original (non extracted) forms had food toxicity, (b) vetiver and citronella grass with a dosage of 5-20% in various formulations can reduce mostch pest populations on corn kernels during a storage period of nine weeks, (c) vetiver can cause higher motsch pest mortality than citronella grass, and a dose of 20% can cause higher mortality than the doses of 5% and 10%, (d) the application of vetiver and citronella grass with a dosage of 5-20% with various formulations (extracted, non-extracted and powders) on corn kernels storage period of nine weeks can reduce the deterioration of kernel

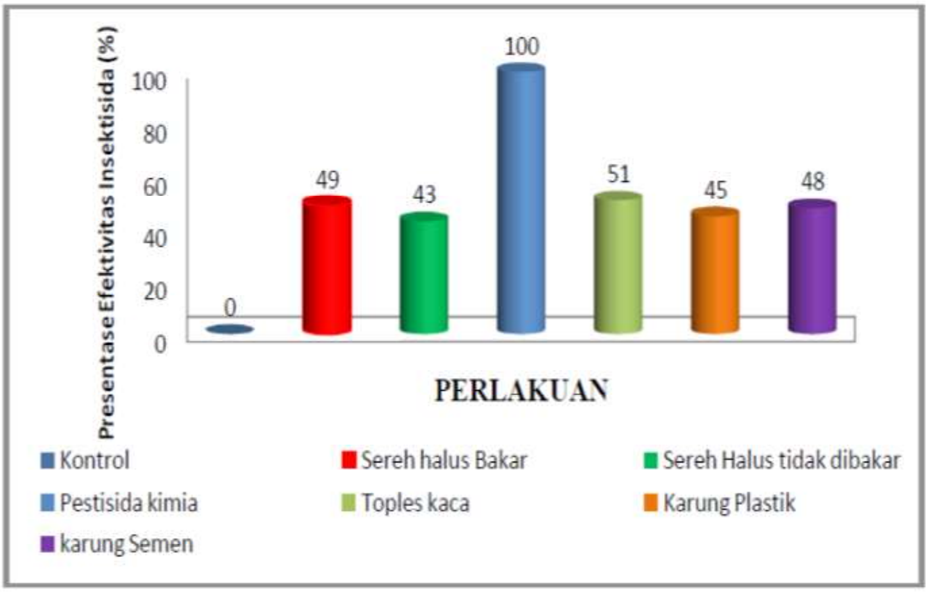

Figure 1. Comparison of the effectiveness of lemongrass bioinsecticides and storage containers with chemical pesticides in killing Mostch pests, conducted at Laboratorium Balai Pusat Informasi Jagung (BPIJ) The Province of Gorontalo, 2014 (Kadir *et al.* 2014).

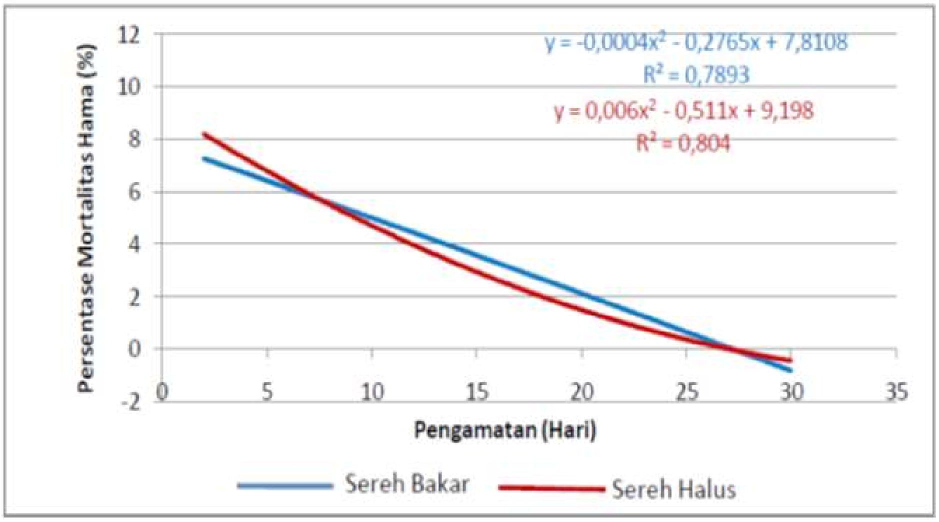

Figure 2. Relationship between the length of investment in the percentage of pest mortality in different preparations, conducted at Laboratorium Balai Pusat Informasi Jagung (BPIJ) The Province of Gorontalo, 2014 (Kadir *et al.* 2014).

weight but does not affect the growth of the seeds (Table 1).

Shallots

Shallot is one type of vegetable that is widely used by Indonesian people after chili and long beans. Shallot is quite popular, especially as a flavoring ingredient, medicine ingredients such as to reduce cholesterol levels, therapy, antioxidants, and antimicrobial.

Shallots contain essential oils, cycloaliin, methylaliin, dihydroaliin, lavonglycosides, saponins, peptides, phytohormones, quercetin and acetogenin. Acetogenin at high concentrations has special antifeedant properties which can cause insects to be less eager to eat. Acetogenin in low concentrations will interfere with the digestive process and damage the digestive organs, which results in insect death (Plantus 2008).

According to Fattah and Syafaruddin (1999) *in* Saenong and Mas'ud. (2009), that shallots can be used as a bioinsecticides because it can reduce the intensity of the attack by 16.12% with an insect mortality rate of 8.14%. Although the ability to kill insects is only 8.14%, but in other experiments with different target insects the results are quite good (Table 2). The repellent effect is quite significant in repelling target insects.

Essential oils contained in garlic contain active components which are acidic. According to Andriana (1999) that garlic extract has a power as an insecticide that can inhibit the development of *Sitophilus* spp. Furthermore, it was stated that by treating only a 7% concentration level it was able to reduce the first descendants of insect population to zero (no F1 population was found).

Hasnah and Usamah (2010) reported that: (1) garlic extract is effective as a bioinsecticides because of the significant effect on mortality rate of *Sitophilus* spp, average time of death, percentage of damage to corn kernels and the number of first descendants that appear, (2) 6% is an effective concentration in controlling *Sitophilus* spp. in the laboratory, with a mortality rate of 85%, (3) at the highest concentration of 12%, it has the highest effect of *Sitophilus* spp. mortality rate, faster death time, lowest percentage of damage to corn kernels and the lowest number of first derivatives that appear, whereas at the lowest concentration of 2% had the following effect on *S. zeamais* (Motsch); lowest mortality rate, longer death time, the highest percentage of damage to corn kernels and the highest number of first of derivatives appears (Table 3).

The essential oils contained in garlic contain acidic active compounds. According to Andriana (1999), garlic extract can serve as insecticide that can inhibit the

Table 1. The mortality of *Sitophilus* spp. with vetiver and citronella grass treatments in original forms and solution formulations after the nine week storage period (%).

Concentration (%)	Vetiver	Citronella grass	Average
5	28,42	24,02	26,22 a
10	34,98	18,57	26,78 a
20	47,62	34,00	40,81 b
Average	37,01 a	25,33 a	

The value followed by the same letter in the same column or row is not significantly different according to Duncan test at the confidence level of 5%
Source: Astriani (2012).

Table 2. The average of final population, intensity of attack, total dead population, and final corn weight.

Treatment	Attack intensity (%)	Total dead population	Final population	Final corn weight
Control	17,21 a	6,22 e	112,00 a	972,14 a
Wood ash	8,14 b	15,13 c	45,17 c	763,12 b
Active charcoal	2,25 c	38,17 a	15,14 e	650,37 b
Betel leaves	4,15 bc	27,11 b	25,10 d	891,31 ab
Shallots	16,12 a	8,14 e	81,25 b	920,13 a
Clove leaves	6,65 b	19,27 c	20,21 de	824,26 ab
Calamus leaves	3,37 c	31,12 ab	12,19 e	712,15 b
Chaff ash	5,18 b	21,25 c	19,01 de	882,51 a

The value followed by the same letter in the same column or row is not significantly different according to Duncan test at the confidence level of 5%
Source: Fattah and Syafruddin (1996) *in* Saenong and Mas'ud (2009).

Table 3. The average mortality of *Sitophilus* spp after the application of garlic extract in various concentrations day after aplication (DAA).

Treatment	Average mortality of *S. zeamais*							
	1DAA	2DAA	3DAA	4DAA	5DAA	6DAA	7DAA	8DAA
K1	0.00 a	2.50 a	6.25 a	11.25 a	16.25 a	22.50 a	27.50 a	32.50 a
K2	3.75 b	8.75 b	15.00 b	26.25 b	35.00 b	46.25 b	58.75 b	68.75 b
K3	6.25 bc	12.50 bc	22.50 bc	31.25 bc	42.50 bc	56.25 c	71.25 c	85.00 bc
K4	7.50 c	15.00 bc	23.75 bc	33.75 bc	45.00 cd	58.75 c	73.75 c	88.75 c
K5	8.75 c	17.50 c	27.50 c	38.75 cd	53.75 dc	68.75 d	83.75 d	97.50 cd
K6	10.00 c	18.75 c	31.25 c	43.75 d	61.25 c	75.00 d	86.25 d	100.00 d
SSD	5.40	6.19	6.56	5.24	5.19	5.20	6.51	14.73

K1=2%, 2 ml garlic extract + 98 ml distilled water; K2=4%, 4 ml garlic extract + 96 ml distilled water; K3=6%, 6 ml garlic extract + 94 ml distilled water; K4=8%, 8 ml garlic extract + 92 ml distilled water; K5=10%, 10 ml garlic extract + 90 ml distilled water; K6=12%, 12 ml garlic extract + 88 ml distilled water

The value followed by the same letter in the same column or row is not significantly different according to Duncan test at the confidence level of 5%

Source: Hasnah and Hanif (2010).

development of *Sitophilus* spp. Furthermore, the treatment with a concentration of 7% could reduce the population of first descendants insect to zero (no F1 population found).

Sweet and Chili Peppers

Sweet and chili peppers (*Capsicum annuum* L.) belongs to family of Solanaceae. There are five species of chili, namely *C. annuum, C. frutescens, C. chinense, C. bacctum, and C. pubescens*. Among the five species, *C.annuum* and *C. frutescens* have the economic potentials (Agusta 2000, Plantus 2008). Chili contains a chemical compound called capsaicin (8-methyl-N-vanillyl-6-nonenamide). In addition, there are also various compounds similar to capsaicin, called capsaicinoids. Meanwhile, chili is a kind of berry fruit with a lanceolate line, bright red color, and spicy taste. The fruit flesh is in the form of non-aqueous pieces, with many seeds and are located in the flesh area**.**

The results of research conducted by Wakman *et al.* (2003) showed that two bioinsecticides could cause significant insect mortality, namely *A. conyzoides*with 86.7% mortality and 65.3% citronella. At a lower concentration (10%) the effectiveness of *A. conyzoides*, the mortality rate of *S. zeamais* Motsh is only 5.7%. Although the chili leaf extract does not show the effect of killing target insects, the repellent effect is quite good. *L. camara* also showed the effect of insecticides on powder beetles but was less effective than *A. conyzoides*and lemongrass. When compared with Decis 2.5 EC inorganic insecticides and Dursban with concentrations of only 0.1% can cause 100% death (Tabel 4). It appears that *A. conyzoides* could be effective up to three days after application, on the fourth day the mortality rate was only

Table 4. The mortality rate of *S. zeamais* Motsch (%) in various concentrations of bioinsecticides ingredient extracts in 24 hour after application.

Herbal ingredients	Concentration (%)		
	50	20	10
Lantana camara	10	4,30	0
Ageratum conyzoides	86,70	35,30	5,70
Andropogonnardus	65,30	45,70	5,30
Capsicum annum	0	0	0
Comparison:			
Decis 2,5 EC (concentration 0,1%)	100	100	100
Dursban (concentration 0,1%)	100	100	100

Source: Wakman *et al.* (2003)

20% and on the fifth day it was no longer effective. *A. nardus* has a shorter effective period of only two days. This fact shows that in fact the four bioinsecticides ingredients function as a repellent, means that if there is a boinsecticide ingredient, the pests will relatively avoid. *A. conyzoides* and *A. nardus* showed better results than others (Table 5).

Black Pepper

One of insecticidal plants is black pepper (*Piper nigrum*). This plant contains active compounds that have toxic effects including saponins, flavonoids, essential oils, kavisin, piperine, piperline, piperolaine, piperanine, piperonal (Conectique 2012 *in* Hasnah *et al.* (2014). Piperine compounds contained in black pepper are

Table 5. Number of moving insects (repellent effect) on the ingredients given corn of 800 g + 20 g of herbal ingredients, and 100 powderpests.

	Herbal ingredientsHours after the application					
	3	6	12	18	24	26
Lantana camara	17	4	3	0	0	0
Ageratum conyzoides	24	12	7	1	1	0
Andropogonnardus	21	7	2	1	0	0
Capsicum annum	15	6	1	0	0	0
Control	1	1	1	0	0	0

Source: Wakman *et al.* (2003).

repellent for *Sitophilus* spp because they emit spicy aroma and flavor that can affect insects in producing eggs and also cause death (Udo *et al.* 2011; Hasnah *et al.* 2014). The aroma and flavor of pepper is determined by the composition of volatile oil, while the spiciness is produced by non-volatile alkaloids, one of which is *piperine*. Based on some literature, pepper plants can control several postharvest pests such as *Sitophilus* spp., *Callosobrunchus* sp., *Lasioderma serricorne*, *Rhizopertha dominica*, and *Tribolium castaneum*. Secondary metabolic compounds produced by this plant can be as *repellents, antifeedants/feeding deterrents*, *oviposition repellents/deterrents* and can also be toxic compounds that can kill insects (Hasnah *et al.* 2014).

Hasnah *et al.* (2014), stated that the application of black pepper powder to corn kernels had an effect on mortality and the number of first-generation imago that appeared as well as the percentage of damage to corn kernels due to the attack of *Sitophilus* spp, but did not affect the duration of appearance. The highest percentage of corn kernel damage was found in the control of 7.88% and the lowest was in the application of black pepper powder at a dose of 1 g/100 g of corn kernels which was 3.10%. The application of black pepper powder 1 g/100 g of corn kernels has been effective in controlling *Sitophilus* spp. because it has mortality rate up to 80% (Table 6). Awoyinka *et al.* (2006) stated that the use of black pepper extract with a concentration of 1.45 mg/mL in 80 minutes could result in the death of 10 imago of *Sitophilus* spp, while Ashouri and Shayesteh (2009) stated that the application of black pepper powder with a concentration of 0.5% (w/w) can kill 90% of *S.granarius* species after 5 days.

Clove Leaf

Since the 1990s, the parts of the clove plant, namely leaves, flowers and stems have also been using as raw materials for bioinsecticides for the control of plant pests and diseases. Cloves (*Syzygium aromaticum*) do not only contain essential oils but also chemical compounds namelyeugenol, oleanolic acid, galoyonic acid, phenilin, resin and gum (Huang 2002, Velluti 2003, Kim 1998). The biggest content of clove oil is eugenol, which is useful in the manufacture of vanillin, eugenyl methyl esters, and eugenyl acetate (Guenther 1990). The workings of the compounds contained in clove leaves are to inhibit anti-feedant activity, resulting in infertility and as a fungicide.

Table 6. The average mortality rate of *Sitophilus* spp due to application of black pepper powder at 1, 2, 3 and 4 day after application.

Treatment	Observation (day after application)			
	1	2	3	4
0.0 g	0.00 a	0.00 a	0.00 a	0.00 a
0.2 g	7.50 abc	20.00 b	40.00 b	57.50 b
0.4 g	10.00 bc	27.50 b	52.50 b	60.00
0.6 g	7.50 ab	35.00 b	45.00 b	62.50 b
0.8 g	10.00 bc	22.50 b	55.00 b	70.00 b
1.0 g	17.50 c	47.50 b	67.50 b	80.00 b

The value followed by the same letter in the same column or row is not significantly different according to Duncan test at the confidence level of 5%.
Source: Hasnah *et al.* (2014).

Utilizing cloves as bioinsecticides for powder beetle pests, it is seen that the ability to reduce the intensity of attacks is not too great, which is only around 6.65%, but the ability to cause insect mortality is relatively high at 19.27%. This situation is caused by the work effects of these pesticides as antifeedant (causing insects to lose appetite), therefore, the mortality that occurs is not due to the effect of contact with insects but death is caused by starvation from insects to food sources (Fattah and Syafaruddin 1999 in Saenong and Mas'ud. (2009).

Sand Ginger (*Kencur*)

Sand Ginger/*Kencur* (*Kaempferia galanga* L.) is a tropical plant that grows in many parts of Indonesia as a cultivated plant. This plant is widely used as a mixture of traditional medicines and spices, so that many farmers cultivate large amounts for trade. The sand ginger available in the market is the rootstocks or rhizomes (Soeprapto 1986). According to Afriastini (1990), the composition of the chemical content of rhizomes of sand ginger consists of; (1) ethyl cinnamic, (2) ethyl p-methoxycinamic, (3) p-metoxistirene, (4) karen (5) borneol, and (6) paraffin. The chemical content which is the main component of sand ginger is ethyl p-methoxycinamic (Afriastini 1990). In addition, the sand ginger plant has an essential oil content of 2.4-2.9% which consists of ethyl paramethoxy sinamat (30%), camphor, borneol, cineol, and pentadecane. Ethyl p methoxycinnamate is a synamat derivative compound (Inayatullah 1997). The chemical compound that play a role in reducing the population of motsch pests is the essential oils.

Timoty (2014), Tukimin *et al.* (2010) suggested that the dried extract of sand ginger and the length of storage of each treatment increased mortality rate of the mostch pest imago, thereby, reducing the number of imago and reducing the weight loss of corn kernels in storage.

PLANTS POTENTIAL AS BIOPESTICIDES THAT PROSPECTIVE TO BE DEVELOPED IN THE FUTURE

Amanupunyo and Handri (2016), Dubey *et al.* (2008), and Suwanto (1994) states that the development of bioinsecticides is quite difficult because of several factors, but the plant-based pesticides have the opportunity to be developed in the future when viewed from the aspect of advantages, include: (1) reducing the risk of pests and developing resistance properties, (2) no adverse effect on natural enemies of pests, (3) reducing the risk of the occurrence of a second pest attack, (4) reducing the danger to the health of human and livestock, (5)no damaging effect on the environment and supplies of ground water and surface water, (6) reducing farmers' dependence on agrochemicals, (7) cheaper costs, (8) cheap and easy to make by farmers, (9) no poison to plants, (10) being compatible when combined with other control methods, (11) producing healthy agricultural products because they are free of residues, (12) low toxicity, (13) not encouraging resistance, easily degraded, and narrow target organisms, (14) more environmentally friendly and more in line with the sustainability needs of small-scale farming, and (15) no pollution to the environment, more specific, having shorter residues and less likely to develop resistance.

Furthermore Amanupunyo and Handri (2016) and Dubey *et al.* (2008) states that bioinsecticdes also have many disadvantages and challeges, among others: (1) less stable, so that it is easily degraded by physical, chemical and biotic influences from its environment, so requiring higher frequency of use than synthetic chemical pesticides, thereby, reducing aspects of practicality, (2) natural herbal ingredients are also contained in low levels, so that, to achieve adequate effectiveness, requiring greater amount of materials, (3) bioinsecticides ingredients are only suitable when used at the level of subsistence farming not in the business of supplying mass agricultural products, (4) if bioactive ingredients are found in flowers, seeds, fruit or parts of plants that on appear in particular season, there will be no certainty of availability which will be an obstacle to further development, (5) difficulty in determining the dosage, the content of the active ingredient in bioinsecticides ingredients needed for the implementation of control in the field, so that the results are taken into account in advance, (6) the working power is relatively slow, (7) not resistant to sunlight, (8) less practical and unable to store, and (9) sometimes must be applied/sprayed repeatedly.

OBSTACLES AND FUTURE DEVELOPMENT STRATEGIES

Obstacles

According to Natawigena (2000), bioinsecticides are considered environmentally friendly and cheap, but the obstacles and prospects for development are not as easy as thought. There are several inhibiting factors in the development, including: (1) The research on bioinsecticdes has still not integrated (the implementation of research on pesticides is still obstructed, causing information and data to be generated that cannot be used as the basis for further development of herbspesticides), (2) The high cost of developing bioinsecticides (the development of bioinsecticides from the selection of target bodies, the selection of active ingredients, the supply of raw materials, extraction, purification, formulation, patents, registration, manufacturing and marketing, requires time and high costs), (3) Farmers' habits (socio-cultural) in using synthetic pesticides (in this period there were still many farmers who thought that the use of synthetic pesticides could guarantee the safety of their crops. Therefore, they kept using the pesticides regardless the emergence of pests, especially on economical plants, as it violates the rules of IPM strategy), (4) The low mastery of technology in producing herbspesticides (the limited mastery of technology in in producing bioinsecticides, from the provision of raw materials to production. Until then, there have not been plant-based plants producing pesticides cultivated by farmers, (5) Synthetic pesticides dominate the market (synthetic pesticides are easy to use and to obtain and the results are immediately visible is an advantage that has urged/eliminated the use of bioinsecticides in the market. Also, in terms of competitiveness, since the synthetic pesticides are made from chemicals and raw materials are available in large quantities makes them relatively cheaper.

Strategies

Kardinan (2011), Utami and Rahyu (1996), and Said (1994) stated that the future development strategies that need to be carried out include: (1) the preparation of raw materials should not be dependent on nature but be cultivated and promoted, so that farmers will be going to plant the raw materials, (2) providing easy and inexpensive processing techniques, so that bioinsecticides can be provided by farmers to meet their needs, (3) increasing public understanding of bioinsecticides, so that they do not depend on synthetic pesticides and are aware that there are still alternative controls through the utilization of bioinsecticides, (4) conducting distribution and marketing to the regions, so that farmers can easily obtain them when needed, (5) conducting research and development to overcome the weaknesses of bioinsecticides in addition to obtaining new findings, and (6) developing the sustainability indicators, among others, can be seen from: (a) farmers' profits; (b) decrease in supply of synthetic chemical pesticides; (c) low residues of chemical pesticides in plants, soil and water; and (d) public acceptance of herbicides.

CONCLUSIONS

Based on the several research findings stated that spices plant contains essential oils of which compositions include citral, citronella, geraniol, myrcene, nerol, farnesol methylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol ($C_{10}H_{18}O$) of 35-40%. Citronella has desiccant effect in their toxicity and act as contact poisson that can cause death of the insect targetsdue to continuous fluid loss. Insects affected by this poisson will die from lack of fluids. In addition, the benefits of lemongrass leaves are also repellent, as well as insecticides, bactericides, nematicides. The anti effect represent by the presence of essential oils, such as cycloaliin, methylaliin, dihydroaliin, lavonglycosides, saponins, peptides, phytohormones, quercetin and acetogenin.

Some of the spices plants contain the compund that represent the anti feeding effect, reppelent, inhibitor that haave the ability to disturbe and the insect, even damagng the nervous system, these are allyl sulfide, allyl propyl disulfide, allyl divinyl sulfide, allyl vinyl sulfoxide, diallyl trisulfide, adenosine, allistin, garlicin, tuberculoside, and phosphorus compounds (from garlic), whereas a chemical compound called capsaicin (8-methyl-N-vanillyl-6-nonenamide) was extracted from sweet and chili pepper. The saponins, flavonoids, essential oils, kavisin, piperine, piperline, piperolaine, piperanine, piperonal found in black pepper that act as repellent can affect insects in producing eggs and also cause death. This plant contains active compounds that have toxic effects including saponins, flavonoids, essential oils, kavisin, piperine, piperline, piperolaine, piperanine, piperonal, eugenol, oleanolic acid, galoyonic acid, phenilin, resin and gum, camphor, borneol, cineol, and pentadecane, those compound can be found at black pepper, cloves sand ginger.

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