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

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 by the community is still limited as ingredients 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, as 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 antipytotopathogenic 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, Garcia-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. ZEAMAINS (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 species. 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 granial (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 L.Rendle) 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...
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 Saaenong 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.

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**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 (%).**

<table>
<thead>
<tr>
<th>Concentration (%)</th>
<th>Vetiver</th>
<th>Citronella grass</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>28,42 a</td>
<td>24,02 a</td>
<td>26,22 a</td>
</tr>
<tr>
<td>10</td>
<td>34,98 a</td>
<td>18,57 a</td>
<td>26,78 a</td>
</tr>
<tr>
<td>20</td>
<td>47,62 a</td>
<td>34,00 a</td>
<td>40,81 b</td>
</tr>
<tr>
<td>Average</td>
<td>37,01 a</td>
<td>25,33 a</td>
<td></td>
</tr>
</tbody>
</table>

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.**

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

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%
The utilization of spices plant as bioinsecticides for controlling maize .... (Ayyub Arrahman and M. Sudjak Saenong)

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

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

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 annum* L.) belongs to family of Solanaceae. There are five species of chili, namely *C. annum*, *C. frutescens*, *C. chinense*, *C. baccatum*, and *C. pubescens*. Among the five species, *C. annum* 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 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 bioinsecticide 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, piperticine, piperonoline, piparanine, 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 powder pests.

<table>
<thead>
<tr>
<th>Herbal ingredients</th>
<th>Hours after the application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Lantana camara</td>
<td>17</td>
</tr>
<tr>
<td>Ageratum conyzoides</td>
<td>24</td>
</tr>
<tr>
<td>Andropogonannardus</td>
<td>21</td>
</tr>
<tr>
<td>Capsicum annum</td>
<td>15</td>
</tr>
<tr>
<td>Control</td>
<td>1</td>
</tr>
</tbody>
</table>


Pepper is a good 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 *Triabolium 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 namely eugenol, 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Observation (day after application)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>0.0 g</td>
<td>0.00 a</td>
</tr>
<tr>
<td>0.2 g</td>
<td>7.50 abc</td>
</tr>
<tr>
<td>0.4 g</td>
<td>10.00 bc</td>
</tr>
<tr>
<td>0.6 g</td>
<td>7.50 ab</td>
</tr>
<tr>
<td>0.8 g</td>
<td>10.00 bc</td>
</tr>
<tr>
<td>1.0 g</td>
<td>17.50 c</td>
</tr>
</tbody>
</table>

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 Afiastini (1990), the composition of the chemical content of rhizomes of sand ginger consists of; (1) ethyl cinnamic, (2) ethyl p-methoxycinnamic, (3) p-metoxistirene, (4) karen (5) borneol, and (6) paraffin. The chemical content which is the main component of sand ginger is ethyl p-methoxycinnamic (Afiastini 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.

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 bioinsecticides 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 herbicides), (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 herbicides (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 (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (Cmethylheptane and dipentene. The highest content is citronella which is equal to 35% and graniol (8-methyl-N-vanillyl-6-nonenamide) was extracted from sweet and chili pepper. The saponins, flavonoids, essential oils, kavisan, pipeline, piperonine, piperonine, piperonaline, piperinal 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, kavisan, pipeline, piperonine, piperonaline, piperinal, egogen, oleasonic acid, galoyonic acid, phellen, resin and gum, camphor, borneol, cineol, and pentedacene, those compound can be found at black pepper, cloves sand ginger.

**REFERENCES**


The utilization of spices plant as bioinsecticides for controlling maize ..... (Ayub Arrraham and M. Sudjak Saenong)


