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The Diversity of Warehouse Pests on Areca Nuts in the West Sumatera, Indonesia

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Abstract

Areca nut is one of Indonesia's leading export commodities that must adhere to certain phytosanitary requirements, including being pest-free. It is infested by several types of insect pests during the storage process. Therefore, this study aims to determine the diversity of warehouse pests that infest areca nuts. It was conducted using a survey method at three warehouses of large collectors and exporters of areca nut in the Padang city and the Padang Pariaman regency. The purposive sampling method was adopted to collect samples from three traders' warehouses. Furthermore, the nut was taken diagonally in a pile, namely the corner and center of 1 kg each, and repeated 4 times. The identification key was used to identify 15 insect types from 10 families and 3 orders. The *Cryptolestes pusillus*, *C. ferugineus*, and *Carpophilus sp.* were found with the highest number of individuals in each warehouse.The diversity index of the three warehouses is 1.78, 2.14, and 1.90 indicating a moderate level. Additionally, the similarity index between warehouses shows a high and very high level of species similarity.

Keywords: Stored pests, areca nut, diversity

1. Introduction

Areca nut (*Areca catechu* Linnaeus) is one of Indonesia's leading export commodities. According to FAO data(2022), Indonesia exported 258,364, 218,198, and 205,200 tons, respectively from 2018 through 2020 to Pakistan, Thailand, India, Singapore, Myanmar, Nepal, Vietnam, Sri Lanka, Bangladesh, and Malaysia(Warta Ekspor, 2017).

Areca nut is known to have a wide range of applications including being used traditionally as an anthelmintic (Xiao et al., 2019) and a mixture of medicinal makers, such as dysentery medicine, and mouthwash(Miftahorrachman et al., 2015). It also has anti-microbial, anti-schizophrenic, anti-inflammatory, and anti-migraine activities (Silalahi, 2020). Furthermore, it is used in the manufacture of areca gum and also in the production of fabric dyes, cotton, and tanning(Miftahorrachman et al., 2015).

Exports of agricultural commodities, including areca nut, must adhere to phytosanitary requirements in the importing country, which are aimed to prevent the spread of quarantine pests and limit the economic losses impact on other important pests (FAO, 2015). One of these requirements is being free from insect infestations, especially in the destination countries such as India (FSSAI, 2011), Pakistan (Ministry of Commerce, 2020), and Japan (Japan External Trade Organization, 2011). Non-compliance can result in detention and rejection in the destination country (Sjam, 2014), which is followed by the notification issuance from the importing to the exporting country (IAQA, 2010). The Agricultural Quarantine Agency received 3 non-conformance notifications in 2020 regarding the discovery of live insects on areca nut exports from Indonesia (IAQA, 2021).

Insect pests that infest areca nut can come from planting, post-harvest process, and even storage process. According to Hagstrum et al. (2009), 15 species of warehouse pests from the order Coleoptera can infest areca nut. Thube et al. (2017) also showed that the most common warehouse pests found in areca nut commodities in India were *C. pusillus, L. serricorne, C. carpophagus, A. fasciculatus,* and *T. castaneum*. Sandra et al (2021) showed that the areca nuts stored in Jambi City and Muaro Jambi Regency are susceptible to infestation by 28 types of insects. However, there are only a few studies on the diversity of warehouse pests that attack areca nut in Indonesia, especially in West Sumatra.

One of the areca nut-producing areas in Indonesia is West Sumatra with a total production of 7,758.70 and 8,917.30 tons in 2020 and 2021, respectively (Statistic Indonesia, 2022). The cultivation area also increased from 13,408.00 to 14,895.95 hectares in 2021 (Statistic Indonesia, 2022). Suryani et al (2019) stated that this nut is a top priority commodity that can be developed in Agam, Lima Puluh Kota, and Sijunjung Regencies. Therefore, the study of warehouse pests on areca nuts is important because they cause severe damage to commodities. Moreover, information on types of warehouse pests on areca nut is also needed to mitigate risk and control pests in fulfilling export requirements.

2. Materials and Methods

The materials used are areca nut, 96% alcohol, label paper, and aquades. The tools used include sample bottles, tweezers, brushes, plastic bags, thermohygrometer, magnifying glass, oven, mortar, porcelain dish, camera, analytical balance, and stereo microscope.

Sample collection and Laboratory analysis

The purposive sampling was adopted in selecting areca nuts that have been stored for more than 2 weeks. At each sampling, the warehouse owner is interviewed about areca nut origin, storage time, post-harvest problems faced, the types of pests found in the storage area, and the control methods used to overcome these pest problems.Sampling is carried out at the warehouses of collectors and exporters in Padang City and Padang Pariaman Regency. Each 1kg sample is taken from piles with 5 different points at the corner and middle of each storage warehouse and placed in a plastic jar covered with gauze with a diameter and height of 27 and 24 cm, respectively. Sampling was carried out 4 times, then athermohygrometer was placed in the warehouse to measure the temperature and relative humidity.

The samples are then observed for types, stadia, and the number of warehouse pests found in the seeds. Warehouse pests were identified based on morphology by referring to books namely Borror and Delong's An Introduction to the Study of Insect (Triplehorn et al., 2005), Atlas of Stored Product Insect and Mite (Hagstrum et al., 2013), and Insect of Stored Grain – A Pocket Reference (Rees, 2007).

Areca Nut Moisture Content in Storage

Areca nut water content was determined based on the procedures outlined in SNI 01-3182-1992 (National Standardization Agency, 1992). The nut was finely ground with a mortar, then 5kg of its powder was placed in a porcelain dish and heated in an oven at a temperature of 105 + 1°C for 5 hours. It is then cooled in a desiccator until reached room temperature and is weighed. Furthermore, it is reheated for 30 minutes, cooled, and weighed. This process is repeated

until the difference between two consecutive weighing is less than 0.001 g. The water content is calculated using the formula below:

$$\text{Water content} = \frac{\text{Initial weight(Mo)-Final weight (M1)}}{\text{Initial weight (Mo)}} \times 100\%$$

Data analysis

The data such as diversity, evenness, and species similarity indexes were analyzed. The diversity index is calculated according to Shannon-Wienner with the following equation:

$$H' = -\sum_{i=1}^{n} pi \ln pi$$

H´: Shannon-Wiener diversity index
pi: Individual proportion of all species i

The evenness index is calculated using the following equation:

$$E' = \frac{H'}{\ln S}$$

E´: Evenness index
S: Number of species found

The species similarity index is calculated using the following equation:

$$Is = \frac{2C}{A + B}$$

IS: Species similarity index
A: Number of species found in the community A
B: Number of species found in community B
C: Number of species found in communities A and B

3. Results and Discussion

Types and Populations of Preca Nut Pests

A total of 15 different Insect pests were found in areca nut samples are 13 generally come from the order Coleoptera. Other orders found are *Lepidoptera* and *Psocoptera*, each with 1 species. The morphologyof insect pests is demonstrated in Figure 1.

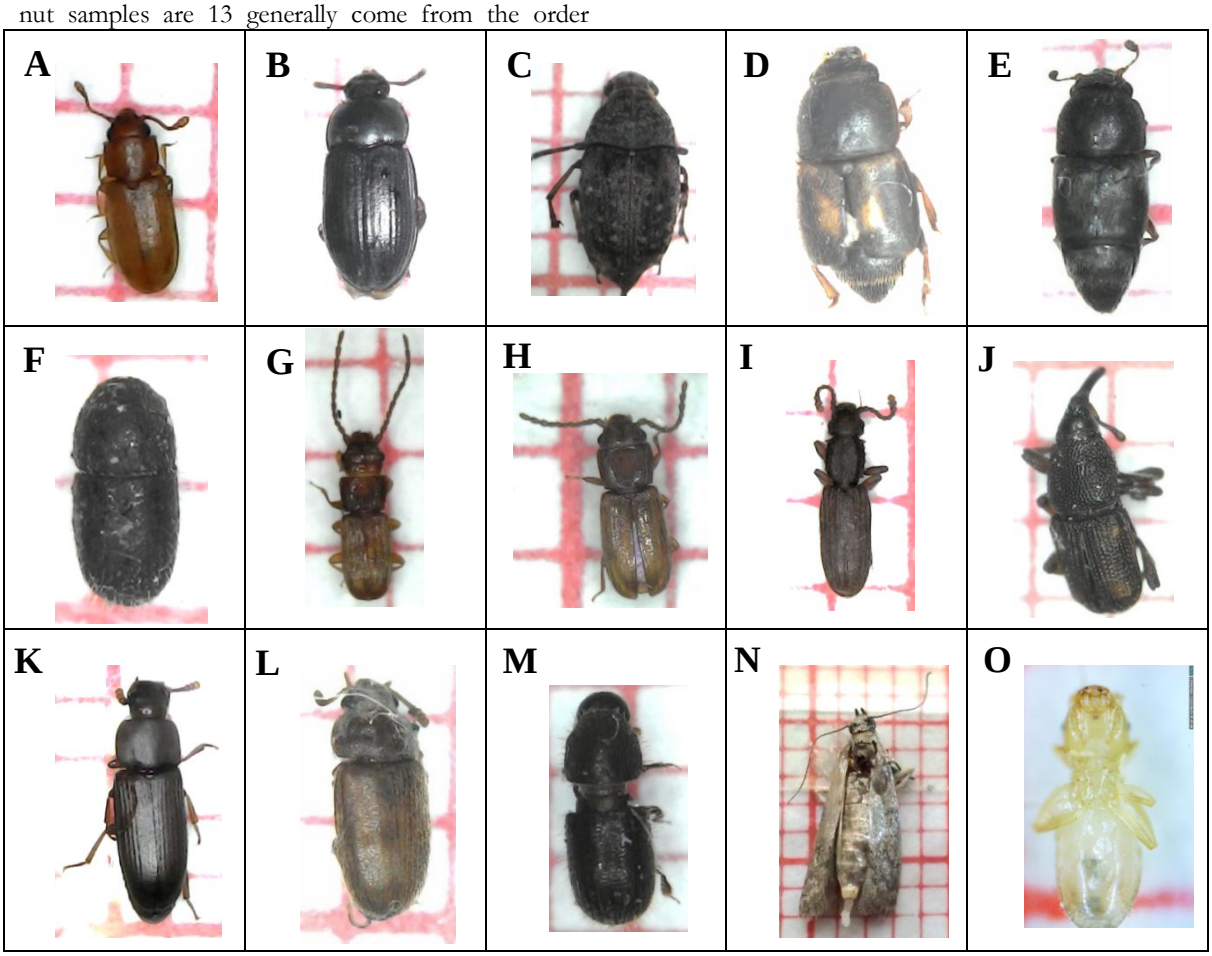

Image 1. Insect pests found in warehouses A. Ahasverusadvena;B. Alphitobiusdiaperinus;C. Araecerusfasciculatus;DCarpophilushemipterus;E. Carpophilussp;F. Cocotrypessp.;G. Cryptolestesferrugineus;H. Cryptolestespusillus;I. Oryzaephilusmercator;J. Sitophilussp.;K.Tribolliumcastaneum; L.Typhaeastercorea; M.SpesiesA; N.Ephestiacautella. O. Liposchelis sp

Figure 1 shows three orders of insects that attack areca nuts in storage. The family of the Order Coleoptera is the most commonly found with a higher number of species than others (Table 1).

Table 1. Types of adult insects found in areca nut

No	Ordo	Famili	Spesies
1	Coleoptera	Anthribidae	*Araecerusfasciculatus*
2		Curculionidae	*Sitophilussp*
3		Laemophloeidae	*Cryptolestesferrugineus*
4			*Cryptolestespusillus*
5		Mycetophagidae	*Typhaeastercorea*
6		Nitidulidae	*Carpophilussp*
7			*Carpophilushemipterus*
8		Scolytidae	*Cocotrypessp*
9			Spesies A
10		Silvanidae	*Ahasverusadvena*
11			*Oryzaephilusmercator*
12		Tenebrionidae	*Alphitobiusdiaperinus*
13			*Tribolliumcastaneum*
14	Lepidoptera	Pyralidae	*Ephestiacautella*
15	Psocoptera	Liposcelididae	*Liposcelis sp.*

The insects found included primary and secondary pests, as well as fungi eaters. Secondary pests such as C.ferrugineus, C.pusillus, and T.castaneum can infest the commodity due to its physical form, namely split areca nut. However, they cannot attack and reproduce successfully on pristine solid commodities (Wagiman, 2019). Fungi-eating insects such as Alphitobiusdiaperinus, Ahasverusadvena, and Typhaeastercorea are often found on the surface of split areca nuts. According to Van der Bijlet al (1996), several species of Aspergillus are often found in split areca nut. Asgharet al (2020) reported that aflatoxin levels of 1.88–378.94 g/kg are found in 39 samples from each shipment of areca nut from Indonesia to India. According to Swain et al (2016), an insufficient drying process can lead to fungal infection. The diversity and distribution of warehouse pests found in the samples are shown in Table 2.

Table 2.The abundance of warehouse pest insects in areca nut samples

No	Species name	Number of individuals in warehouse		
		I	II	III
1	*Ahasverusadvena*	19	13	49
2	*Alphitobiusdiaperinus*	-	2	-
3	*Araecerusfasciculatus*	7	11	31
4	*Carpophyllussp*	3	5	70
5	*Carpophyllushemipterus*	2	-	5

6	*Coccotrypessp*	19	-	2
7	*Cryptolestesferrugineus*	2	26	2
8	*Cryptolestespusillus*	41	5	22
9	*Ephesteiacautella*	-	1	2
10	*Liposcelissp*	-	2	4
11	*Oryzaephilusmercator*	-	-	1
12	*Tribolliumcastaneum*	14	12	31
13	*Typhaeastercorea*	5	5	10
14	*Sitophilussp*	-	2	-
15	Scolytidae Species A	-	9	-
	Number of individuals	112	93	229
	Number of species	9	12	12

The number of species in areca nut originating from warehouses II and III are more than those in I. Meanwhile, the highest abundance is 229, 112, and 93 individuals in Warehouse III, I, and II, respectively. Several factors cause the presence of pests, including physical environmental conditions and the presence of other hosts. Furthermore, several commodities are stored in a warehouse, which can be hosts for a pest.

The type and abundance of insects in storage are influenced by the presence of other commodities. The observation results on warehouse conditions show that there are other commodities in II and III, namely cocoa beans and gambier. Meanwhile, only areca nut is stored in I. According to Hagstrum and Subramayam (2009), 96 types of insects can infest cocoa beans in storage areas. This number is more, compared to those that infest areca nut, which is 15 species (Hagstrum and Subramanyam, 2009). Furthermore, cocoa was stored in the same warehouse as areca nut, which may have influenced the number of species found.

The type of insect that has the highest abundance for each warehouse is different. In Warehouse I, the insects with the highest abundance were *C.pusillus*, while in II and III are *C.ferugineus* and *Carpophilus* sp. These three species are classified as secondary pests (Rees, 2007), which can multiply when the commodity is not intact.

Based on the diversity and distribution of pests, 7 types were found in all warehouses, namely *A.advena*, *A.fasciculatus*, *Carpophillus* sp, *C.ferrugineus*, *C.pusillus*, *T. castaneum*, and *T.stercorea*. These pests, including cosmopolitan pests, have a very wide distribution in the world (Rees, 2004). Furthermore, the three types of insects found in all the warehouses, namely *A.advena*, *Carphopilus* sp, and *Typhaea* sp are also observed in areca nuts exported to India (IAQA, 2021).

The analysis of the diversity, species evenness, and richness indexes of insects found in the areca nut samples is shown in Table 3.

Table 3.Values of Shannon Wiener Diversity Index and Species Evenness Index,

No	Parameter	Warehouse		
		I	II	III
1.	Species	9	12	12
2.	Individual	112	93	229
3.	Diversity Index (H')	1.78	2.14	1.90
4.	Diversity Level	Moderate	Moderate	Moderate
5.	Evenness Index (E)	0.38	0.47	0.35

The value of insect diversity in warehouses I, II, and III ranges from 1.78 to 2.14, which are categorized as moderate (Fachrul, 2007). Furthermore, the species evenness index value for warehouses I and III is in a low category, while II is moderate. This low value indicates the dominance of certain species in the community. The results of the species similarity index analysis between warehouses I, II, and III are shown in Table 4.

Table 4.The index value of species similarity between warehouses

Parameter	The species similarity index in the warehouse		
	I	II	III
I	-	0.67*	0.86**
II	-	-	0.75*
III	-	-	-

*Description: *=high level of similarity **=very high level of similarity*

The species similarity index value between warehouses I and III is very high, while I and III as well as II and III showed a high level of similarity. This indicates that the three warehouses contain a lot of the same species and their storage conditions are relatively similar. The measurement of temperature and humidity at the time of sampling in warehouse I is 31.9-32.5 °C with an rH of 63-65%. Meanwhile,]II and III are is 29.7-34.4 °C and 29.5-33.5 °C with rH of 62-68% and 64-69%, respectively. Furthermore, the feeding activity of insect pests can also cause damage to areca nuts. The damages to areca nut due to insect activity are demonstrated in Figure 2

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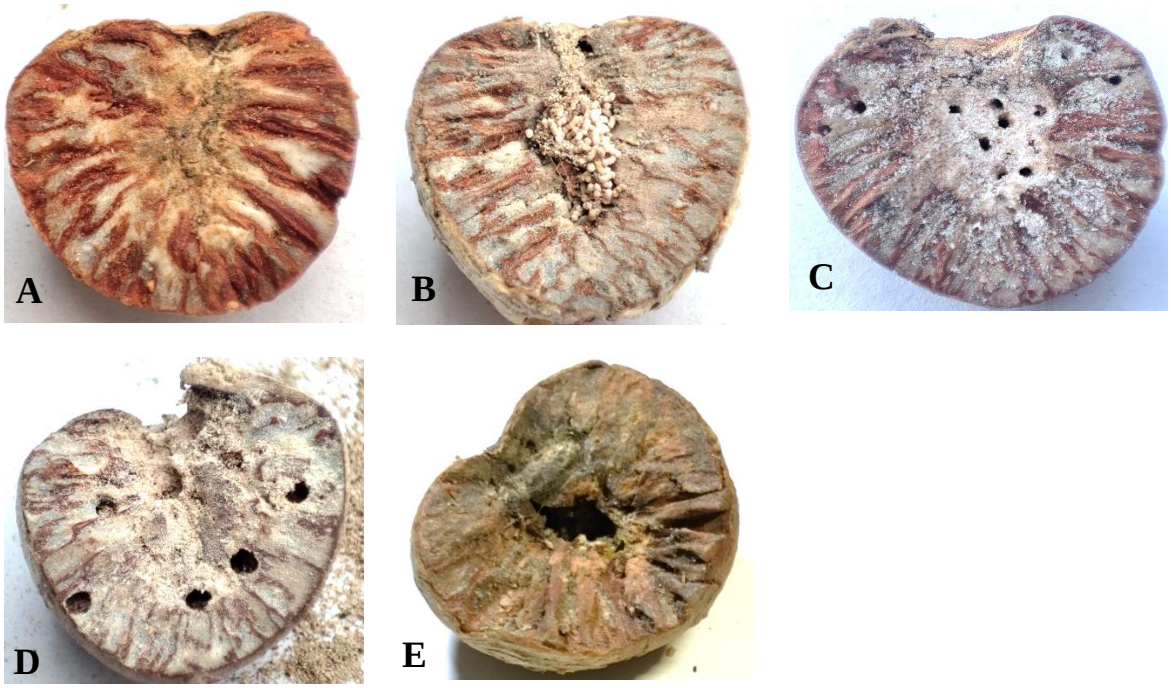

Figure 2. Areca nut damage due to insect attack. A. Areca nuts are normal; B. Damage in the form of a thread-like braid; C. Damage in the form of a hoist with a diameter of +1 mm; D. Damage in the form of a hoist with a diameter of + 3 mm; E. Damage in the form of a hole in the core of the seed

The results show that areca nuts can be damaged either randomly or in the center of the seed. Damage typically affects the seed's endosperm and perisperm, which has a harder structure and resembles wood. Insect activity was found to be thread-like fabric or powder form, which corresponds to the symptoms found by Thube et al (2017) in areca nut in India. Damage in the form of powder and braided threads indicates an infestation of the order Coleoptera and Lepidoptera, respectively (Wagiman, 2019). Furthermore, the symptoms of attack by secondary pests may not be visible in observation. According to

Wagiman (2019), they are generally not typical and it is difficult to know the cause. Moreover, the damage due to insect activity is also influenced by the moisture content of the areca nut. The water content analysis results are shown in Table 5.

Table 5. The moisture content of areca nut samples

Location/Warehouse	Moisture content (%) of areca nut at the -th sampling				Average
	1	2	3	4	
I	13.60	8.24	9.94	8.08	9.96
II	12.96	12.43	12.80	19.98	14.54
III	14.40	12.61	12.28	14.40	13.42

The results show that the moisture content of all areca nut samples is above export standard, which is<5%. Furthermore, the SNI standard for non-medicated areca nut is a maximum of 14% for quality I and 15% for II (National Standardization Agency, 1997). According to Wagiman (2019), post-harvest pests generally require 8-10% water content to live normally, thus a higher value can lead to increased competition of fungi and other microorganisms, which will rapidly increase their mortality rate.

4. Conclusions

This study found 15 species of pests in areca nut at the storage warehouses in West Sumatera. The species with the highest number of individuals found in each warehouse are*Cryptolestes pusillus*, C. *ferugineus*, and *Carpophilus* sp. Additionally, the diversity index of the three warehouses is 1.78, 2.14, and 1.90 indicating a moderate level of diversity. Meanwhile, the species similarity index between warehouses shows a high and very high level.

References

[1] Asghar, Muhammad Asif, Ahmed, A., Asghar, Muhammad Arif, 2020. Comparison of aflatoxins contamination levels in betel nuts (Areca catechu L.) imported from Asian countries. Agric. Food Secur.9, 8.https://doi.org/10.1186/s40066-020-00263-9

[2] Fachrul, M.F., 2007. Bioecology Sampling Methods. BumiAksara, Jakarta.

[3] FAO Food and Agriculture Organization, 2022. Top 10 Country, Export Quantity of Areca nuts [WWW Document]. FAOSTAT Ctry.Commod. URL https://www.fao.org/faostat/en/#rankings/countries_by_commodity_exports (accessed 1.3.21).

[4] Food Agriculture Organization, 2015.ISPM 1 Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade.Food Agriculture Organization.

[5] FSSAI Food Safety Standard Authority of India, 2011. Food Safety And Standards (Food Products Standards And Food Additives) Regulations. Food Safety Standard Authority of India, New Dehli.

[6] Hagstrum, D.W., Klejdysz, T., Subramanyam, B., Nawrot, J. (Eds.), 2013.Atlas of stored-product insects and mites.AACC International, St. Paul, Minn.

[7] Hagstrum, D.W., Subramanyam, B., 2009. Stored-product insect resource.AACC International, St. Paul, Minn.

[8] IAQA Indonesian Agricultural Quarantine Agency, 2021. Indonesian Agricultural Quarantine AgencyAnnual Report 2020. Indonesian Agricultural Quarantine Agency, Jakarta.

[9] IAQAIndonesian Agricultural Quarantine Agency, 2010. Plant Quarantine Export Certification System Guidelines. Indonesian Agricultural Quarantine Agency, Jakarta.

[10] Jain, V., Garg, A., Parascandola, M., Chaturvedi, P., Khariwala, S.S., Stepanov, I., 2017. Analysis of Alkaloids in Areca Nut-Containing Products by Liquid Chromatography–Tandem Mass Spectrometry. J. Agric. Food Chem. 65, 1977–1983. https://doi.org/10.1021/acs.jafc.6b05140

[11] JETRO Japan External Trade Organization, 2011.Guidebook for Export to Japan (Food Articles). Japan External Trade Organization, Tokyo.

[12] Miftahorrachman, Matana, Y.R., Salim, 2015. Areca nut Cultivation and Post-Harvest Technology. Indonesian Palmae Research Institute, Manado.

[13] Ministry of Commerce, 2020. Import Policy Order. Ministry of Commerce, Islamabad.

[14] NSAI National Standardization Agency of Indonesia, 1997. SNI 01-3450-1997 Areca nut not for medicinal purpose.National Standardization Agency of Indonesia, Jakarta.

[15] NSAI National Standardization Agency of Indonesia, 1992. SNI 01 - 3182 - 1992.Determination of Water Content.National Standardization Agency of Indonesia, Jakarta

[16] Rees, D., 2004. Insects of stored products. CSIRO [u.a.], Collingwood, Vic.

[17] Rees, D.P., 2007. Insects of stored grain: a pocket reference, 2nd ed. ed. CSIRO Publishing, Collingwood, Vic.

[18] Sandra, S., Lizawati, L., Wilyus, W., 2021.Detection of Insect Pests in Areca Seed (Areca catechu L.)Storage Warehouses Using Several Sampling Methods. J. Media Pertan. 6, 29. https://doi.org/10.33087/jagro.v6i1.113

[19] Schowalter, T.D., 2016. Insect ecology: an ecosystem approach, 4th edition. ed. Elsevier, Amsterdam San Diego.

[20] Silalahi, M., 2020.Areca nut (Areca catechu) Benefits and Toxicity in Human Health.BinaGener. J. Kesehat. 2, 26–31.

[21] Sjam, S., 2014.Post Harvest Pest and Controlling Strategy. IPB Press, Bogor.

[22] Statistics Indonesia, 2022. West Sumatra Province in Figures 2022.Statistics Indonesia of West Sumatra Province, Padang.

[23] Suryani, N., Budiman, C., Hidayat, R., 2019. Mapping of Leading Commodities in the Agricultural Sector in West Sumatra Province. JOSETA J. Socio-Econ. Trop. Agric. 1. https://doi.org/10.25077/joseta.v1i2.152

[24] Swain, S., Sachidadananda, Din, Ram, C., Bandla, G., 2016. Post harvest processing and value addition in coconut, areca nut and spices. pp. 152–157.

[25] Thube, S.H., Pandian, R., Bhavishya, Saneera, E., Mohan, C., Nagaraja, N., 2017. Major storage insect pests of

Arecanut*Areca catechu* L.: A Survey. J. Entomol. Zool. Stud. 5, 1471–1475.

[26] Triplehorn, C.A., Johnson, N.F., Borror, D.J., 2005.Borror and DeLong's introduction to the study of insects, 7th ed. ed. Thomson, Brooks/Cole, Australia.

[27] van der Bijl, P., Stockenström, S., Vismer, H., Wyk, C.W., 1996. Incidence of fungi and aflatoxins in imported areca nut samples. South Afr. J. Sci. 92, 154–156.

[28] Wagiman, F.X., 2019. Post Harvest Pest and Management. Gajah Mada University Press, Yogyakarta.

[29] Warta Ekspor, 2017.PeluangEksporGambirdanBiji Pinang. War. Ekspor.

[30] Xiao, Y., Yang, Y., Yong, J., Lu, C., 2019. Chemical Components and Biological Activities of Areca catechu L. Biomed.Res. Rev. 3. https://doi.org/10.15761/BRR.1000131