International Journal for Research in Applied Sciences and Biotechnology

ISSN: 2349-8889
Volume-8, Issue-1 (January 2021)

www.ijrasb.com

https://doi.org/10.31033/ijrasb.8.1.12

A Review on Tubli Plant used as Organic Pesticide: Input toward Sustainable Agriculture

Enrique E. Biñas, Jr
College of Agriculture and Forestry, Jose Rizal Memorial State University-Tampilisan Campus, ZNAC, Tampilisan, Zamboanga del Norte, PHILIPPINES

Corresponding Author: enriquebinas@jrmsu.edu.ph

ABSTRACT

The use of a botanical pesticide like tubli plant crude extracts is one of the practical methods for those farmers who are not capable to incur the expensive commercial pesticides. This contributes to the sustainability of agriculture because it has no adverse effects on the environment. This review article introduces the characteristics of tubli plant and assesses its efficacy as an organic pesticide. The most strong and effective pesticidal property of tubli plant is rotenone which controlled various pests. This had been cultivated and used as an organic pesticide all over the world. Some studies revealed that the application of tubli plants enhanced farmers' productivity of farms and the profitability of their income. Tubli plant is adapted to be one of the inputs toward sustainable agriculture.

Keywords- Indigenous, Organic Pesticide, Rotenone, Sustainable Agriculture, Tubli Plants

I. INTRODUCTION

Background

There are a lot of synthetic pesticides that can prevent and control pests even in a large farm area (Schreinemachers *et al*., 2011), however, rampant use of synthetic pesticides alone can adversely affect the environment and health, and even reduce income. (Mitra *et al*., 2011; Agri-Green, 2011b; Edwards, 2013). Akwar *et al*. (2009) also believed that the overuse of synthetic pesticides could deplete soil fertility and yield. Hence, Sparagano *et al.* (2016) suggested that the use of synthetic pesticides must be reduced to prevent deterioration of soil and income. Organic pesticides can be integrated into an inorganic pesticide (Baker *et al*., 2002). This contributes to the sustainability of agriculture because it has no adverse effects on the environment (Dubey *et al*., 2010). Integration of organic and inorganic pesticides is an example of sustainable agricultural practices that minimize and protects the environment, develop the earth's natural resource base, and improve soil fertility systems (Reganold *et al*., 1990). The goal of sustainable agriculture is to (1) increase farm income and production, and (2) improve the lives of farm families and communities. Integrated system practices are designed to produce long-term results such as (1) production of sufficient food, and other agricultural-related products, (2) expansion of the natural resources supply and protection of the environment, and (3) sustainment of the economic viability of agriculture systems (Freenstra *et al.*, 1997).

Crop production is the art of producing crops at increasing productivity and quality of products to maximize the monetary returns while eliminating the negative impact on the environment (Basra *et al.*, 2018). One of the intensive cultivation management to achieve this goal and make agriculture sustainable is through the application of organic pesticides to control the occurrence and damage of pests to crops (Matthew, 2003;Matthew, 2008).One of the sources of organic pesticides is the plant that has pesticidal properties. Tubli (*Derris elliptica* (Wall). Benth) is one of the most plants possessing strong pesticidal properties (Rejesus *et al.*, 1993; Prakash, 1996).). Tubli is a leguminous plant that originated in Southern Asia and the Southwest Pacific islands (The Plant List, 2010). It is also known as tuba in Indonesia (Fryer, 1923). Its crude extracts had been discovered and used as a pesticide by some of the farmers and researchers in various countries including the Philippines (Devi, 2016). It had been also used by the students in their laboratory exercises and experiments in various Universities. Botanical pesticide derived from tubli plants is also sold to some of the pesticide marketing outlets all over the world (Sola *et al.*, 2014).

The use of a botanical pesticide like tubli plant crude extractsis one of the practical methods for those farmers who are not capable to incur the expensive commercial pesticides. Besides, this is the best input in attaining sustainable agriculture. Utilization of the available resources for farming can be practiced only if farmers know the importance and uses of this indigenous botanical pesticide (Wilcox, 2011; Sola *et al.*, 2014).

Physical Appearance of Tubli

Table 1 shows the different parts and descriptions of tubli plant. The image of its parts can be seen in figure 1. Generally, it is a climbing plant that belongs to the lianas kind of plant.

Table 1: Parts and description of tubli

Part	Description	Reference
Plant	Climbing	(Philippine Medicinal Plants)
Branches	Covered with brown hairs	
Leaves	Pinnate, 30 to 50 cm long	
Leaflets	Oblong, 9 to 13 cm, when matured: smooth above, and subglaucous and silky beneath, 10 to 15 cm long	
Racemes	Lax, 15 to 30 cm length, reddish flowers in a stalked cluster	
Pods	5 to 8 cm long and contain 1 to 3 seeds, flat and brown or black	
Branchlets, rachices, petioles, petiolules	Brown pubescent	(Floral of China Editrial Committee, 2018)
Old branches	Glabrous, scattered with brown lenticels	

(a) **(b)** **(c)**

Figure 1: Appearance of tubli: (a) leaves; (b) flower; (c) whole parts

Other Kinds of Tubli Plants

Plants have different characteristics that distinguish their structures even they are in the same family and genus (Sheldrake, 2005). Table 2 introduces the different common names and genus and species of tubli plants. The only scientific name that is accepted for a species in the genus Derris and family Leguminosae is *Derris elliptica* (Wall). Benth (The Plant List, 2010).

Table 2: Other kinds of tubli

Common Name	Scientific Name	Reference
Bauit (Tag.)	*Cylistapiscatoria* Blanco	The Plant List 2010. Retrieved from: Derris elliptica (Wall.) Benth. — The Plant List
Lapak (Bik.)	*Degueliaelliptica* (Benth.) Taub.	
Malasiag (Tag.)	*Derris elliptica* (Wall.) Benth.	
Opay (N. Viscaya)	*Galactiaterminaliflora* Blanco	
Tibalau (Tag.)	*Galedupaelliptica* Roxb.	
Tibanglan (Tag.)	*Milletiapiscatoria* Merr.	
Tubli (P. Bis., Tag., Buk.)	*Milletiasplendidissima* Vidal	
Tugli (Tag.)	*Pongamiaelliptica* Wall.	
Tugling-pula (Tag.)	*Pongamiavolubilis* Zoll. &Moritzi	

Table 3 reveals the other vernacular names of tubli in selected nationalities. A vernacular *name is* used for a species in one area may refer to a different species in another.

Table 3: Other vernacular names of tubli

Nationality	Vernacular Name	Reference
Filipino	Tubli	The Plant List 2010. Retrieved from: Derris elliptica (Wall.) Benth. — The Plant List
Brunei	Tuba	
Burmese	Hon	
Chinese	Du Yu Teng, Nan Ya Yu Teng, Mao Yu Teng	
Fijian	Nduva, Duva Ni Vavalgai	
French	Touba	
German	Derris-Wurzel, Tuba-Wurzel.	
Indonesian	Tuba, OyodTungkul	
Malaysian	Akar Tuba, Tuba, Tuba Benar	
Thai	Lai Nam, Hang Lai Daeng	
Vietnamese	D[Aa]Y Thu [Oos]C C[As].	

Tubli Discovered and Used in Several countries

Several countries used tubli as a source of pesticide. They cultivated this plant to maintain the availability in their locality. Countries that often cultivated and used tubli is presented in Table 4.

Table 4: Countries that cultivated and used tubli as a source of pesticide

Country	Reference
Africa	
Congo	(USDA-ARS, 2018)
Mauritius	(ILDIS, 2013)
Nigeria	(PROTA, 2018)
Reunion	(ILDIS, 2013)
Tanzania	(USDA-ARS, 2018)
Asia	
Bangladesh	(USDA-ARS, 2018)
Indonesia	(ILDIS, 2013)
• Borneo	(USDA-ARS, 2018)
• Irian Jaya	
• Maluku Islands	(PROSEA, 2018)
• Sulawesi	
• Sumatra	(USDA-ARS, 2018)
Cambodia	
China	(Flora of China Editorial Committee, 2018)
• Guangdong	
• Guangxi	
• Hainan	
• Yunnan	

India	(USDA-ARS, 2018)
• Andaman and Nicobar Islands	(ILDIS, 2013)
• Assam	(USDA-ARS, 2018)
• Meghalaya	
• Odisha	
• Punjab	
• Tamil Nadu	
• West Bengal	
Japan	(Toyoda, 2003)
• Bonin Islands	
Laos	(USDA-ARS, 2018)
Malaysia	
• Sabah	(PROSEA, 2018)
• Sarawak	
Myanmar	(USDA-ARS, 2018)
Nepal	
Philippines	(Orwa *et al.*, 2009)
Singapore	(ILDIS, 2013)
Sri Lanka	
Taiwan	(Flora of China Editorial Committee, 2018)
Thailand	(USDA-ARS, 2018)
Vietnam	(ILDIS, 2013)
North America	
Cuba	(Oviedo Prieto and Gonzales-Oliva, 2015)
Honduras	(Molina, 1975)
Martinique	(ILDIS, 2013)
US Virgin Islands	(Acevedo-Rodriguez and Strong, 2012)
United States	(PIER, 2018)
• Hawaii	
Oceania	
Christmas Island	(ILDIS, 2013)
Cook Islands	(PIER, 2018)
Federated States of Micronesia	
• Chuuk	
• Kosrae	
• Pohnpei	(Herrera *et al.*, 2010)
• Yap	(PIER, 2018)
Fiji	(Smith, 1985)
Guam	(PIER, 2018)
Northern Mariana Islands	
Palau	(Space *et al*., 2003)
Papau New Guinea	(USDA-ARS, 2018)
Tonga	(PIER, 2018)

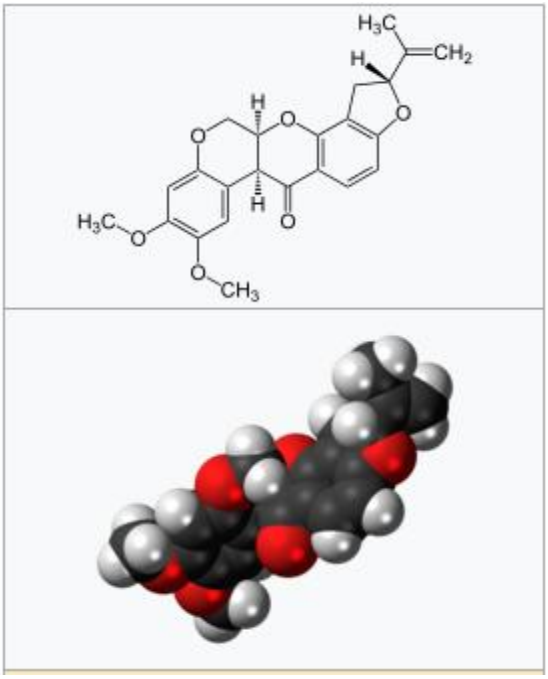
Pesticidal Properties of Tubli

The part of tubli that produces a white milky sap when pounded is the roots. Roots contain an insecticidal compound called rotenone which is a white crystalline, derrid, anhydroderrid, derrin, tubotoxin, and tubain. The strongest compound is the rotenone. The rotenone constituents are rotenoids–4',5'-dihydroxy-6a,12a-dehydrodegueline, and 11,4'5'-trihydroxy-6a,12a dehydrodeguelin. Rotenone is more effective against plant lice, leaf beetles, aphids, flies, caterpillars, ticks, chicken lice, red spiders, and other insects than potassium cyanide or nicotine. It is equally effective as the pyrethrum. It can also be considered a poisonous plant. There are cases in the Philippines that animals died from eating more leaves of this plant. Tubli also contains lipid with constituents including three ceramides and a poly-hydroxyl octadecenoic acid, 12, 13, 15-trihydroxy-9-octadecenoic acid that is also considered effective in controlling insects (Philippine Medicinal Plants).

II. DISCUSSION

Rotenone

Tubli sap contains rotenone. It can be pounded from the stem, leaves, and most especially from the roots. Most of the lianas plants that belong to the family Fabaceae possess rotenone. The rotenone-containing plants were discovered to be the best alternative bioinsecticide for killing caterpillar and poisoning fishes in 1848 (Metcalf, 1948). French botanist Emmanuel Geoffrroy isolated the active chemical component in 1895. He called it *nicouline*for it got from the *Robinianicou* specimen which is now called *Lonchocarpusnicou*. The efficacies of plants belong to the family Fabaceae were introduced in many thesis research studies and published posthumously in 1895 after his death (Ambrose and Haag, 1936). The rotenone compound was named and also isolated by the Japanese chemical engineer Kazuo Nagai. The word rotenone comes from the



Source: Rotenone-Wikipedia

Figure 2: Chemical structure of rotenone: (2*R*,6a*S*,12a*S*)-1,2,6,6a,12,12a-hexahydro-2 isopropenyl-8,9-dimethoxychromeno[3,4-*b*]furo(2,3-h)chromen-6-one / Tubatoxin, Paraderil

Japanese word "roten". Because of the discoveries, the nicouline and rotenone were finally established to be useful in farming by 1930 (La Forge *et al.*, 1933). The government agencies of the United States used already the tubli as a source of rotenone for many purposes in fishing and farming (Tanner *et al.*, 2011; Schmidt, 2014; Daroff and aminoff, 2014).

Biopesticidal

As the rotenone has been long discovered as a biopesticide it was found out that it is more effective in a form of emulsifiable concentrate than in water-dispersible granules in controlling *Spodopteralitura* (Wiwattanapatapee *et al*., 2009).

The root of tubli can be isolated as an alkaloid from a methanol extract with a concentration of 0.1%. This can act as a biopesticide agent that controls *Scotinopharacoartata* E. (Musa *et al*., 2018).

Larvicidal

There are a lot of studies on the ethanol extracts against the larvae of *A. aegypti*. One of the effective

control was from the tubli plant. (Komalamisra *et al.*, 2005). Mosquito larvae were also controlled by larvicidal activity (LC50) of the plant root. In three hours of treatment, there was a 50% mortality with the use of tubli crude extracts. (Akunne *et al.*, 2018). It was also reported that it kills beetles in potato, raspberry, asparagus and cucumber, and cabbage worms as well as most of the arthropod larvae (Cavoski *et al.*, 2008).

Insecticidal

Tubli roots are effective against insects not only in the form of extracts but also in powder. Tubli root powder can even control the *Balanogastrickolae* on kola nut. It was found out that the application of tubli root powder at 10g and 15g concentration performed well resulted in the highest mortality during the exposure period (Akunne *et al*., 2018).

Acaricidal

Tubli plant is rich also inacaricidal property. This was used in the study against *Rhipicephalussanguineus* (brown dog tick). The tubli roots were undergone first in air-drying before it was pounded. It was applied as a foliar spray in three different concentrations i.e., 1.5, 1.6, 2.0%. This can be an alternative for syntheticacaricides (Alolino *et al.*, 2017).

Rodenticidal

The tubli (*Derris elliptica*) can also be used with the combination of other botanical pesticides like nami (*Dioscoreahispida*). Their combinationis found to be effective in killing mice. This is a cheap potential and natural alternative rodenticide (Torrefiel, 2014).

Rotenoids

Rotenoids are compounds that occurred naturally. These chemicals areconsidered the cousins of rotenone. They are necessary for the inhibition of the complex I of the electron transport chain. They are in the extracts that contain rotenone because of the synthesis happened (Daroff and Aminoff, 2014). Rotenoids also contains a cis-fused tertrahydrochromeno [3,4-b]chromenenucleus Tubli plants was studied to be yielded with seven rotenoids: (1) 7′-hydroxy-6a, 12a-dehydrodeguelin, (2) 6-hydroxy-6a, 12a-dehydrodeguelin, (3) (6aR, 12aR, 4′R, 5′S)-4′, 5′-dihydro-4′, 5′-dihydroxytephrosin, (4) 6′-hydroxy-6a, 12a-dehydrorotenone, (5) (-)-rotoic acid, (6) (-)-deguoic acid, and (7) 12-deoxo-12α-acetoxyelliptone (Lu *et al.*, 2018).

Extraction of Rotenone / Pressurized Liquid Extraction Compared to Maceration

Pressurized Liquid Extraction (PLE) technique of rotenone was found to be the best way for it consumed less time compared to the conventional maceration techniques. (Sae-Yun, *et al.*, 2006)

Evaluation for Cytotoxicity and Genotoxicity

The tubli was evaluated for its cytotoxicity and genotoxicity using Vitotox assay. It was found that tubli is not genotoxic nor cytotoxic (Chichioco-Hernandez *et al*., 2011).

Antioxidant / Inhibition of Heinz Body Induction

Tubli was one of the 20 medicinal plants used in the study using screened aqueous extracts in Thailand for antioxidant activity and inhibition of Heinz body induction caused by oxidants. Tubli has also performed the highest percent inhibition of Heinz body inhibition activity (Palasuwan *et al*., 2005).

Alternative Green Additive to Increase Rotenone Yield / Roots

Rotenone extraction from tubli roots was conducted using alcohol-based DES or deep eutic solvents as a medium of extraction. It was found out that the combination of the DES with selective organic solvent has similar potential and efficacy as ILs in extracting bioactive constituents in the phytochemical extraction process (Othman *et al*., 2015)

Extraction Kinetic / Normal Soaking Extraction Method / Effect of Exposure / Roots

The rotenone was found to be sensitive to light and heat. It cannot be exposed to extreme environments with an improper extraction system. There is a tendency that the major bioactive compounds will be lost and its effectiveness of insecticidal action will have deteriorated (Zubairi *et al*., 2014).

Embryotoxicity and Teratogenicity on Fish Embryo

The 0.05% tubli crude extract can reduce the hatchability rate, slower heartbeat, and delayed formation of the fish embryo. 0.50% can cause undeveloped head and tail regions, coagulation, and death of the embryo. This concentration increases Teratogenic and lethal effects (Tolentino *et al*., 2016).

Sustainability in Agriculture

The use of indigenous botanical pesticides is one of the contributors to sustainable agriculture (Ignacimuthu and Vendan, 2018). It has been implemented to be practiced by the farmers. This practice is still encouraged to be maintained all over the world (Dixon *et al*., 2014). Many botanical pesticides including tubli crude extracts are already recommended to achieve and maintain the concept of sustainable agriculture (Dimetry, 2012). Tubli is the most promising botanical pesticide that promotes a balanced and self-regulated agricultural system (Indigenous Plants as Natural Pesticides, 2017). Aside from conserving the soil fertility and the environment, the application of botanical pesticides like tubli crude extracts can increase the monetary returns of the farmers and sustain the productivity and profitability of their farms and income, respectively (Alburo and Olofson, 1987; Geisen, 1999; Javier *et al.*, 2003; bTacio, 2009; Agri-Green, 2011a).

III. CONCLUSION

The use of botanical pesticides is needed for the fulfillment of sustainable agriculture and the enhancement of crop production. Tubli plant is considered one of the most strong and effective botanical pesticides all over the world. It had been tested and

proven that this can control and mitigate the adverse effects of pests on crops and brought profitable income and productive farms to the farmers. It is therefore that the tubli plant is useful in farming and thus, qualified to be an input to sustainable agriculture.

REFERENCES

[1] Acevedo-Rodríguez, P., Strong, M. T., 2012. *Catalogue of the Seed Plants of the West Indies*, Washington, DC, USA: Smithsonian Institution.1192 pp. http://botany.si.edu/Antilles/WestIndies/catalog.htm

[2] Akunne, C. E., Okeke, E. M., &Ononye, B. U. (2018). Toxicity of Root Powder of Derris elliptica for the Control of Kola Weevil, Balanogastriskolae in the Stored Kolanut. *Advances in Bioscience and Bioengineering*, *6*(1).

[3] Aktar, W., Sengupta, D. and Chowdhury, A., 2009. Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary toxicology*, *2*(1), pp.1-12.

[4] Alburo, R. and Olofson, H., 1987. Agricultural history and the use of botanical insecticides in Argao, Cebu. *Philippine quarterly of culture and society*, *15*(3), pp.151-172.

[5] Alolino, S. M. G., Aritrangco, I. S., Capistrano, G. M. N., Cruz, G. P. D., & Felisarta, J. R. A. (2018). Acaricidal Activity of Spray Prepared from Derris Elliptica (Tubli) Root Extract Against Rhipicephalus Sanguineus (Brown Dog Tick). *Advancing Pharmacy Research*, *4*(1).

[6] Ambrose, A. M., & Haag, H. B. (1936). Toxicological Study of Derris1. *Industrial & Engineering Chemistry*, *28*(7), 815-821.

[7] A Misture of Tibanglan or Tubli (Derris elliptica) and Nami or Intoxicating Yam (Dioscoreahispida) as an Alternative Rodenticide / Crislyn Keith Torrefiel / 2014-2-15 INTEL Philippines Science Fair

[8] Baker, B.P., Benbrook, C.M., Iii, E.G. and Benbrook, K.L., 2002. Pesticide residues in conventional, integrated pest management (IPM)-grown and organic foods: insights from three US data sets. *Food Additives & Contaminants*, *19*(5), pp.427-446.

[9] Basra, S.M., Hussain, M., Wahid, A. and Farooq, M., 2018. 16 Crop Diversification. *Developing Sustainable Agriculture in Pakistan*, p.311.

[10] Cavoski, Ivana; Caboni, Pierluigi; Sarais, Giorgia; Miano, Teodoro (2008-08-06). "Degradation and Persistence of Rotenone in Soils and Influence of Temperature Variations". *Journal of Agricultural and Food Chemistry*. *56* (17): 8066–8073. doi: 10.1021/jf801461h. PMID 18681442.

[11] Chichioco-Hernandez, C., Wudarski, J.,Gevaert, L., &Verschaeve, L. 2011. Evaluation of cytotoxicity and genotoxicity of some Philippine medicinal plants. *Pharmacognosy magazine*, *7*(26), 171.

[12] Daroff, R.B. and Aminoff, M.J., 2014. *Encyclopedia of the neurological sciences*. Academic press.

[13] Devi, P., Shukla, V., & Meshram, Y. K. 2016. *A review on the use of botanical pesticides in insect pest management.*

[14] Dimetry, N.Z., 2012. Prospects of botanical pesticides for the future in integrated pest management programme (IPM) with special reference to neem uses in Egypt. *Archives of Phytopathology and Plant Protection*, *45*(10), pp.1138-1161.

[15] Dixon, P., Cass, L., Vincent, C. and Olfert, O., 2014. *Implementation and adoption of integrated pest management in Canada: Insects. In Integrated Pest Management (pp. 221-252)*. Springer, Dordrecht.

[16] Dubey, N. K., Shukla, R., Kumar, A., Singh, P., & Prakash, B. (2010). Prospects of botanical pesticides in sustainable agriculture. *Current Science*, *98*(4), 479-480.

[17] Edwards, C.A. ed., 2013. *Environmental pollution by pesticides (Vol. 3).* Springer Science & Business Media.

[18] Feenstra, G., Ingels, C., & Campbell, D. (1997). *What is sustainable agriculture. web document]*. *UC Sustainable Agriculture Research and Education Program*: University of California at Davis.

[19] Flora of China Editorial Committee, 2018. *Flora of China. In: Flora of China*. St. Louis, Missouri and Cambridge, Massachusetts, USA: Missouri Botanical Garden and Harvard University Herbaria. http://www.efloras.org/flora_page.aspx?flora_id=2

[20] Fryer, J.C.F. 1923. "A Quantitative Study Of The Insecticidal Properties Of Derris Elliptica (Tuba Root)". *Annals of Applied Biology*. *10* (1): 18–34. doi:10.1111/j.1744-7348.1923.tb05651.x.

[21] Geisen, J., 1999. The Sustainable Vegetable Production Project in Guimaras-empowering local farmers to increase farm income through environmental-friendly vegetable production. Der Tropenlandwirt-*Journal of Agriculture in the Tropics and Subtropics*, *100*(1), pp.99-111.

[22] Herrera, K., Lorence, D. H., Flynn, T., Balick, M. J., 2010. Checklist of the Vascular Plants of Pohnpei, Federated States of Micronesia with Local Names and Uses. *Allertonia*, *10*, 1-192. https://www.jstor.org/stable/23193787

[23] ILDIS, 2013. *International Legume Database & Information Service.* Reading, UK: School of Plant Sciences, Unversity of Reading.http://www.ildis.org/

[24] Indigenous Plants as Natural Pesticides. 2017. Retrieved from Indigenous Plants As Natural Pesticides (pinoybisnes.com)

[25] Ignacimuthu, S. and Vendan, S.E., 2008. *Botanical pesticides in insect pest management. Emerging trends of researches in insect pest management and environmental safety, Volume I*, pp.141-154.

[26] Javier, P.A., Sison, M.L.Q. and Ebora, R.V., 2003. *Integrated pest management in the Philippines*. Integrated pest management in the global arena, CABI, p.239.

[27] Komalamisra, N., Trongtokit, Y., Rongsriyam, Y., & Apiwathnasorn, C. (2005). Screening for larvicidal activity in some Thai plants against four mosquito vector

species. *Southeast Asian Journal of Tropical Medicine and Public Health, 36*(6), 1412.
[28] La Forge, F. B., Haller, H. L., & Smith, L. E. 1933. The Determination of the Structure of Rotenone. *Chemical Reviews, 12*(2), 181-213.
[29] Lu, H. Y., Liang, J. Y., Yu, P., Qu, W., & Zhao, L. (2008). Two new rotenoids from the root of Derris elliptica. *Chinese Chemical Letters, 19*(10), 1218-1220.
[30] Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A, 2009. *Agroforestree Database: a tree reference and selection guide. Version 4. In: Agroforestree Database: a tree reference and selection guide*. Version 4. Nairobi, Kenya: World Agroforestry Centre. http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp
[31] Othman, Z. S., Hassan, N. H., &Zubairi, S. I. (2015, September). *Alcohol based-deep eutectic solvent (DES) as an alternative green additive to increase rotenone yield. In AIP conference proceedings (Vol. 1678, No. 1, p. 050004).* AIP Publishing LLC.
[32] Oviedo Prieto, R., González-Oliva, L., 2015. National list of invasive and potentially invasive plants in the Republic of Cuba - 2015. (Lista nacional de plantas invasoras y potencialmente invasoras en la República de Cuba - 2015). *Bissea: Boletín sobre Conservación de Plantas del Jardín Botánico Nacional de Cuba, 9*(Special Issue No. 2), 1-88. http://repositorio.geotech.cu/jspui/bitstream/1234/1476/4/Lista%20nacional%20de%20plantas%20invasoras%20de%20Cuba-2015.pdf
[33] Matthews, G. 2008. *Pesticide application methods*. John Wiley & Sons.
[34] Matthews, G., Wiles, T., &Baleguel, P. 2003. A survey of pesticide application in Cameroon. *Crop Protection, 22*(5), 707-714.
[35] Metcalf, RL. 1948. *The Mode of Action of Organic Insecticides*. National Research Council, Washington DC
[36] Mitra, A., Chatterjee, C., & Mandal, F. B. (2011). Synthetic chemical pesticides and their effects on birds. *Res J Environ Toxicol, 5*(2), 81-96.
[37] Molina R., A., 1975. A list of the plants of Honduras. (Enumeracion de las plantas de Honduras). *Ceiba, 19*(1), 1-118.
[38] Palasuwan, A., Soogarun, S., Lertlum, T., Pradniwat, P., &Wiwanitkit, V. 2005. Inhibition of heinz body induction in an invitro model and total antioxidant activity of medicinal Thai plants. *Asian Pacific Journal of Cancer Prevention, 6*(4), 458.
[39] Philippine Medicinal Plants. Retrived from Tubli / Derris ellipticaBenth / poison vine / tuba root: Philippine Alternative Medicine / Medicinal Herbs / StuartXchange
[40] PIER, 2018. *Pacific Islands Ecosystems at Risk. In: Pacific Islands Ecosystems at Risk Honolulu, Hawaii, USA*: HEAR, University of Hawaii. http://www.hear.org/pier/index.html
[41] Prakash, A., & Rao, J. 1996. *Botanical pesticides in agriculture*. CRC press.
[42] PROSEA, 2018. *Plant Resources of South-East Asia. Bogor, Indonesia*: PROSEA Foundation. http://proseanet.org/prosea/e-prosea.php
[43] PROTA, 2018. *PROTA4U web database. In: PROTA4U web database Wageningen and Nairobi, Netherlands\Kenya*: Plant Resources of Tropical Africa. https://www.prota4u.org/database/
[44] Rejesus, B. M., Ocampo, V. R., Maini, P. N., Quintana, E. G., Javier, P. A., Inocencio, E., ... & San Juan, E. (1993). *Potential of tubli (Derris sp.) as insecticide. In 24. Annual Scientific Meeting of the Pest Management Council of the Philippines*. Cebu City (Philippines). 4-7 May 1993..
[45] Reganold, J. P., Papendick, R. I., & Parr, J. F. (1990). Sustainable agriculture. *Scientific American, 262*(6), 112-121.
[46] Sae-Yun, A., Ovatlarnporn, C., Itharat, A., & Wiwattanapatapee, R. (2006). Extraction of rotenone from Derris elliptica and Derris malaccensis by pressurized liquid extraction compared with maceration. *Journal of Chromatography A, 1125*(2), 172-176.
[47] Schmidt, Peter (28 February 2010). *"One Strange Fish Tale"*. The Chronicle of Higher Education. Retrieved 24 September 2015.
[48] Schreinemachers, P., Sringarm, S., &Sirijinda, A. (2011). The role of synthetic pesticides in the intensification of highland agriculture in Thailand. *Crop protection, 30*(11), 1430-1437.
[49] Sheldrake, R. (2005). *New science of life*. Icon Books Ltd.
[50] Smith, A. C., 1985. *Flora Vitiensis nova: a new flora of Fiji (Spermatophytes only). Volume 3: Angiospermae: Dicotyledones, families 117-163, Lawai, Hawaii, USA*: Pacific Tropical Botanical Garden.vi + 758 pp.
[51] Sola, P., Mvumi, B. M., Ogendo, J. O., Mponda, O., Kamanula, J. F., Nyirenda, S. P., ... & Stevenson, P. C. (2014). Botanical pesticide production, trade and regulatory mechanisms in sub-Saharan Africa: making a case for plant-based pesticidal products. *Food Security, 6*(3), 369-384.
[52] Space, J. C., Waterhouse, B. M., Miles, J. E., Tiobech, J., Rengulbai, K., 2003. *Report to the Republic of Palau on invasive plant species of environmental concern. In: Report to the Republic of Palau on invasive plant species of environmental concern. Honolulu, Hawaii, USA*: USDA Forest Service, Pacific Southwest Research Station, Institute of Pacific Islands Forestry.https://www.sprep.org/att/IRC/eCOPIES/Countries/Palau/11.pdf
[53] Sparagano, O., Pritchard, J. and George, D., 2016. *The future of essential oils as a pest biocontrol method. In Bio-Based Plant Oil Polymers and Composites* (pp. 207-211). Elsevier Inc..
[54] Tanner, C.M., Kamel, F., Ross, G.W., Hoppin, J.A., Goldman, S.M., Korell, M., Marras, C., Bhudhikanok, G.S., Kasten, M., Chade, A.R. and Comyns, K., 2011.

ISSN: 2349-8889
Volume-8, Issue-1 (January 2021)

https://doi.org/10.31033/ijrasb.8.1.12

Rotenone, paraquat, and Parkinson's disease. *Environmental health perspectives*, *119*(6), pp.866-872.
[55] Tacio, H.D., 2009. *Organic botanical pesticides:* Cheaper and effective pest control.
[56] The Bioactive Alkaloid from Derris elliptica (Roxb.) as Biopesticide Agents of Scotinopharacoartata E on Rice Crops / Weny Musa, Chairunisah J Lamangantjo and Jusna Ahmad / *Journal of Chemical and Pharmaceutical Research, 2018; 10*(3): pp 104-107
[57] The plant List. 2010. *Retrieved from Derris elliptica (Wall.) Benth*. — The Plant List
[58] Tolentino, J. J. V., Kalaw, S. P., Reyes, R. G., & Undan, J. R. 2016. Mycelial growth performance of three Pleurotus species on corn varieties in the Philippines. *Advances in Environmental Biology*, *10*(7), 155-161.
[59] Tolentino, J., & Undan, J. R. 2016. Embryo-toxicity and teratogenicity of Derris elliptica leaf extract on zebraish (Danio rerio) embryos. *Int. J. Pure Appl. Biosci*, *4*, 16-20.
[60] Toyoda T, 2003. *Flora of the Bonin Islands. Kamakura, Japan*: Aboc-sha Press.
[61] USDA-ARS, 2020. Germplasm Resources Information Network (GRIN). Online Database. In: Germplasm Resources Information Network (GRIN). Online Database, Beltsville, Maryland, USA: National Germplasm Resources Laboratory. https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysimple.aspx
[62] Wilcox, C. 2011. *Mythbusting 101: organic farming> conventional agriculture*. Scientific American Blog. July, 18.
[63] Wiwattanapatapee, R., Sae-Yun, A., Petcharat, J., Ovatlarnporn, C., &Itharat, A. (2009). Development and evaluation of granule and emulsifiable concentrate formulations containing Derris elliptica extract for crop pest control. *Journal of agricultural and food chemistry*, *57*(23), 11234-11241.
[64] Zubairi, S. I.,Sarmidi, M. R., & Aziz, R. A. 2014. *A preliminary study of rotenone exhaustive extraction kinetic from Derris elliptica dried roots using normal soaking extraction (NSE) method*. Advances in Environmental Biology, 910-916.
[65] Zubairi, S. I., Sarmidi, M. R., & Aziz, R. A. 2015. A PRELIMINARY STUDY ON MOSQUITO LARVICIDAL EFFICACY OF ROTENONE EXTRACTED FROM MALAYSIA DERRIS sp. *Jurnal Teknologi*, *76*(1).