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Food security: Assessment of insecticidal potentials of ethanolic extracts of C*apsicum chinense* and *Chromolaena odorata* as protectants of *Oryza sativa* against weevils infestation

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Abstract
Weevil infestations in harvested crops can harm their nutritive value and marketability. While synthetic pesticides and insecticides can be expensive and hazardous to human health, this study examined the insecticidal properties of ethanolic extracts from *Chromolaena odorata* and *Capsicum chinense* against *Sitophilus oryzae*. The researchers extracted fresh leaves, young shoots, and flowers from C. odorata and tested 2ml of the different concentrations of plant extracts against *S. oryzae*. After a 24-hour interval for three days, they determined the mortality rate of *S. oryzae* in 2ml extracts of *Chromolaena odorata* and *Capsicum chinense*. The results indicated that both *C. capsicum* and *C. odorata* showed insecticidal potential, and the effect of the plant extracts varied as the concentration and time of exposure increased. At 72 hours, both plant extracts resulted in 100% mortality. This study demonstrated the efficacy of *C. odorata* and *C. capsicum* ethanolic extracts as botanical solutions against *S. oryzae*, a rice weevil. It recommended their commercial trial for sustainable food security in Nigeria and beyond.

Keywords: Ethanol, potency, resistance, infestation, organisms.
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Introduction

The role of plants in sustaining human life on Earth cannot be overemphasized. They provide essential resources, such as food, shelter, and medicine, to all living creatures, both directly and indirectly. Some plants even possess natural insect repellents that help protect crops. Proper pest control is crucial in preventing significant damage to stored plant products (Lannacone & Lamas, 2003). With it, the care and investment put into crop production can be protected during storage. While synthetic insecticides were once commonly used for pest control, they come with environmental and health risks such as toxic residues, pest insect resistance, and harm to natural predators (Lannacone & Lamas, 2003; Viglianco *et al*., 2006). In order to address the challenge of controlling pests and insects in a manner that is safe for both the environment and human health, it is imperative to explore alternative solutions that offer improved efficiency. Utilizing substances derived from the secondary metabolism of plants is a well-known strategy for achieving such environmentally friendly outcomes. These substances have been shown to provide effective solutions that pose minimal risk to the environment and human health (Hernandez-lauzardo *et al*., 2007; Salvadores *et al*., 2007; Oyedeji *et al*., 2020).

Plant extracts have become increasingly popular as a sustainable and eco-friendly approach to addressing a variety of plant-eating insect species (Clemente *et al*., 2006). These extracts contain a blend of secondary metabolites that are not vulnerable to insect resistance, making them a highly effective pest management solution (Valladares *et al*., 2003). Of the roughly 2,000 plant species that have been identified as having pest control potential, the Euphorbiceae, Asteraceae, Fabaceae, Solanaceae, and Poaceae families are among the most widely recognized (Jeremy 1990; Oyedeji *et al*., 2020). In general, secondary metabolites can alter development and behavior of the insects and sometimes causes death of the insects. The biological activities of several species of three families; Annonaceae, Solanaceae and Meliaceae as a result of their active compounds have been reported (Castillo *et al*., 2010). Extracts (powders, aqueous and pulp) were obtained, in particular, from the Solanaceae family, which have insecticidal and repellant effect against various insect species (Pascual-Villalobos 1998; Moreggiani 2001).

Rice (*Oryza sativa* L.) belongs to the Poaceae family. The most prominent crop globally, it serves as the primary sustenance for approximately half of the world's population. Rice, wheat, and maize collectively contribute to 49% of the total caloric intake of individuals. Specifically, rice accounts for 23% of these calories, wheat contributes 17%, and maize provides 9%. Rice constitutes around 25% of the total calorie intake worldwide (Subudhi *et al*., 2006). Moreover, rice exerts a substantial influence on both the economy and food security (Timmer *et al*., 2010). Considering that rice provides 23% of the total calories and 15% of the protein in the human body, it is important to provide careful attention to both the quantity and quality of rice (Gnanamanickam 2009). While biotechnology techniques may enhance these two factors, there are substantial worldwide constraints on the production of this lucrative crop. Annually, substantial reductions in rice yield are caused by rice pests and diseases. Several insects, including the Mexican rice borer, sugarcane borer, fall army worm, chinch bug, grasshoppers, blister beetles, and leaf hoppers, pose a threat to rice crops. The rice weevil (*Sitophilus oryzae*), a bug that is found worldwide, is believed to have originated in India. The biochemical and morphological characteristics of this species closely mirror those of *Sitophilus zeamais* (Gallo *et al*., 2002).

Because of its high reproductive capacity, ability to spread between individuals, extensive infestation, ability to infest a wide range of hosts, and the fact that both the eggs and adults inflict damage, this pest has been identified as the main threat to stored rice (Gallo et al., 2002). Additional studies revealed substantial damage caused by weevils to stored grains, such as the formation of heat cavities, the growth of molds within the grain mass, and a decrease in product value (Puzzi 1986). The insufficient storage conditions of grain result in insect losses ranging from 0.2% to 30% of the grain output, as stated by Pinto et al. (2019). Additionally, there are reports suggesting that these insect losses, both in terms of quantity and quality, could potentially surpass 50% of production (Pinto *et al*., 1997).

Siam weed, scientifically known as *Chromolaena odorata* (L.) R.M. King & H. Robinson, is an invasive plant species that has extensively proliferated in tropical and subtropical regions worldwide, including Nigeria (Uyi *et al*., 2016). *Chromolaena odorata* stems and roots possess pesticidal and unpleasant qualities. The efficacy of the plant's aqueous extract in deterring or eliminating rice weevils in significant quantities remains uncertain.

Capsicum chinense, commonly referred to as Scotch Bonnet (in Jamaica), congo pepper (in Trinidad and Tobago), chile habanero yellow (in Mexico and Belize), ata-rodo (in Yoruba), and gina (in Ijaw), is a plant that people use to battle cowpea weevils. This belongs to the Solanaceae family. The efficacy of C. *chinense* seed powder against the test insect pest makes it suitable for the development of ecologically friendly pesticides derived from plants (Ashouri and Shayesteh, 2010). The efficacy of the *Capsicum chinense* aqueous extract in repelling or exterminating cowpea weevils in large quantities is still uncertain. Given that rice holds great importance as a staple crop in Nigeria, this study aims to evaluate the insecticidal effects of ethanolic extracts derived from C. *chinense* and C. *odorata* on *Sitophilus oryzae*.

Materials and Methods

Collection of plant materials

This study utilized two plant species, namely C. *odorata* and C. *chinense*. The Niger Delta University premises were surveyed to gather fresh leaves, young branches, and flowers of C. *odorata,* which were then placed inside a polythene bag. The entire plant and its fruits of C. *chinense* were gathered from the Niger Delta University Research Farm, Wilberforce Island and transported to the laboratory.

Collection of rice weevils

The stock culture of the rice weevil was established by gathering adult specimens of S. *oryzae* from rice grains afflicted with the pest in a grocery store located in Amassoma market, Bayelsa state. The weevils were cultivated in the laboratory using sanitized rice grains under normal temperature and humidity conditions.

Preparation of plant extracts

The specimens were subjected to natural desiccation at ambient temperature for a duration of 72 hours. The desiccated samples were individually mixed using a blender and then transferred to storage bottles. An electric weighing balance was used to measure the weight of each plant sample, which included 2 g, 4 g, 6 g, and 8 g, using a spatula. Each of the measured samples was transferred into a reagent container and appropriately labeled. Each reagent vial containing the samples was filled with 100 cc of 100% ethanol and left undisturbed for a period of 72 hours. The filtration process involved passing the substance through a Whattman filter paper positioned within a funnel. The remaining substance was disposed of and the liquid that passed through the filter was left to evaporate for a period of 24 hours.

Plate 1: Plant extracts of *Chromolaena odorata* and *Capsicum chinense*

Plate 2: Plates containing weevils

Insect mortality test

A total of 10 mature weevils were placed in each Petri dish, which were labeled according to the weight of the plant extract: 2 g, 4 g, 6 g, 8 g, and control. Subsequently, 2 ml of the distinct concentrations of plant extracts from *C. chinense* and *C. odorata* were precisely measured using a syringe and used separately on the weevils. These measured quantities were then added to separate Petri dishes that already contained the weevils. A control consisting of 2 ml of distilled water was utilized. The experiment was duplicated on five separate occasions. We recorded weevil mortality over a period of three days. The mortality rate of weevils was monitored, quantified, and documented every 24 hours. The insects were pronounced deceased upon receiving no reaction to the application of a sharp pin to the abdomen.

Results

Effect of ethanolic extract of C. *odorata* on S. *oryzae*

The results of the impact of the ethanolic extract of C. *odorata* on S. *oryza* are presented in Table 1. The acquired result demonstrated a diverse range of mortality in all the treatment groups at different time intervals of exposure. When compared to the control group, the extract of C. *odorata* at a concentration of 2 g resulted in mortality rates of 30%, 40%, and 50% within 24-72 hours of exposure (Figure 1). The plant extract caused mortality rates of 50%, 60%, and 70% during a time frame of 24-72 hours after exposure, using a dosage of 4g. When exposed to 6g and 8g of the extract, the test organism experienced mortality rates ranging from 70% to 100%, whereas the control group only had a mortality rate of 10% (Figure 1). The findings demonstrated that the ethanolic extract of *C. odorata*, when administered at different dosages and exposure durations, had a notable impact on the death rate of the test organism.

Table 1: Effect of ethanolic extract of *C. odorata* on the mortality of *S. oryzae*

TIME	2g	4g	6g	8g	Control	Mean
24	3.40 ±0.89^{c}	5.00± 0.71^{a}	7.20±0.84^{a}	10.0±0.00^{a}	0.00±0.00^{a}	5.120^{a}
48	4.00±0.71c	7.00±1.22^{c}	8.20±0.22^{b}	10.00±0.00^{a}	0.00±0.00^{a}	5.840^{b}
72	2.80±0.45^{a}	6.20±0.84^{b}	8.20±0.84^{b}	10.00±0.00^{a}	1.40±0.55^{b}	5.720^{b}
Total	3.40b	6.06^{c}	7.86^{d}	10.00^{e}	0.46^{a}	5.560

Values are means ± standard deviation. Means in the same column having the same superscripts are not significantly different (p>0.05).

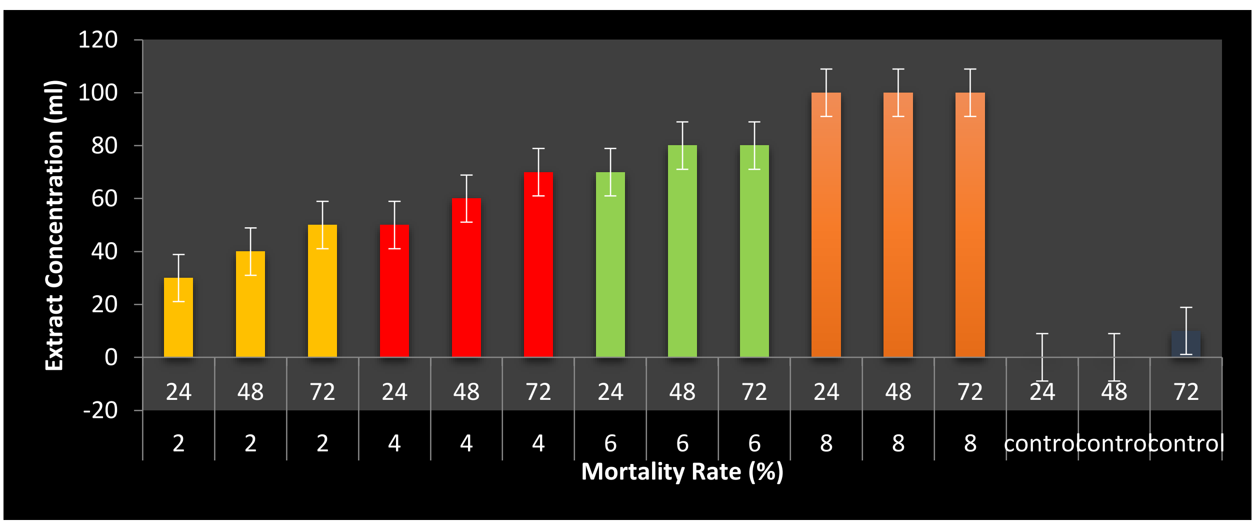

Figure 1: Mean distribution effects of *C. odorata* plant extract on mortality of *S. oryzae* after 24-72 hr of exposure

Effect of ethanolic extract of *C. chinense* on *S. oryzae*

The mortality rate of *S. oryzae* was assessed in relation to the impact of the entire plant body of *C. chinense*, as shown in Table 2. The results demonstrated a significant disparity between the concentration time and the control group. The 2 g concentration of the extract resulted in a mortality rate of 40-80% over the application period, as shown in

Table 4.2. The extract exhibited the highest mortality rate (60%) at 72 hours post-exposure, when administered at a dosage of 4 g. Similarly, there was a death rate of 80% at 24 and 48 hours, respectively, when the dosage was 6 g. In addition, the extract of C. *chinense* at a dosage of 8 g resulted in complete mortality of the test organism, as shown in Figure 2. Based on this outcome, it was noted that the mortality impact of the extract from the entire plant body of C. *chinense* was dependent on the concentration and duration of exposure.

Table 2: Effect of ethanolic extract of C. *chinense* on the mortality of S. *oryzae*

Time	2g	4g	6g	8g	Control	Mean
24	4.00±1.22[b]	6.20±0.84[a]	8.20±0.84[a]	10.0±0.00[a]	0.00±0.00[a]	5.680[a]
48	6.60±1.42[c]	6.40±0.55[a]	8.00±0.71[a]	10.00±0.00[a]	0.00±0.00[a]	6.200[b]
72	3.40±0.55[a]	7.00±0.55[b]	8.40±0.55[a]	10.00±0.00[a]	1.40±0.55[b]	6.040[ab]
Total	4.667[b]	6.533[c]	8.200[d]	10.000[e]	0.467[a]	5.973

Values are means ± standard deviation. Means in the same column having the same superscripts are not significantly different ($p>0.05$).

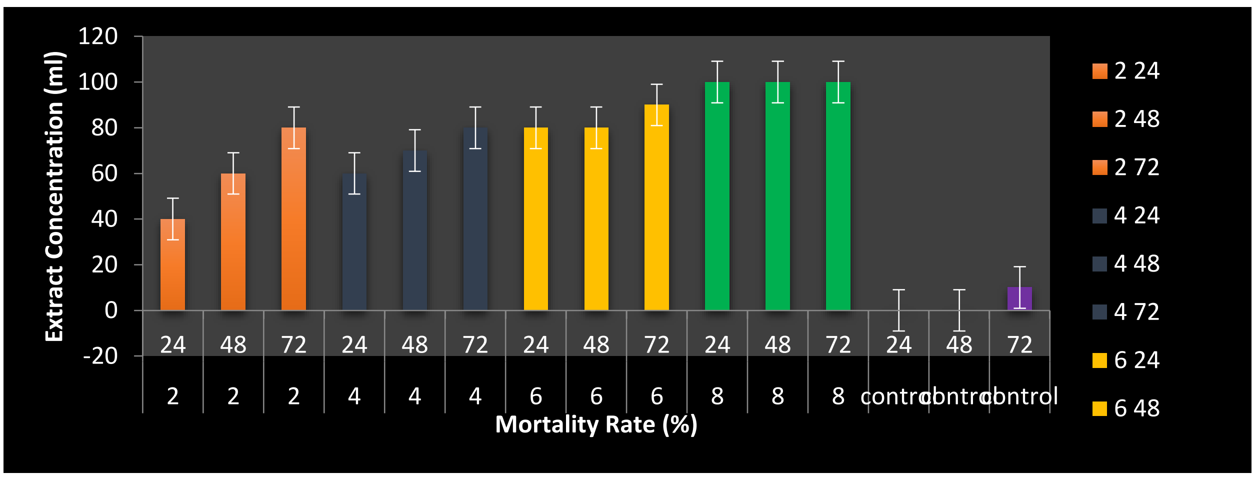

Figure 2: Mean distribution of *C. chinense* plant extract on mortality of S. *oryzae* after 24-72hours of exposure.

Discussion

This study examined the insecticidal properties of an ethanolic extract derived from C. *odorata* and C. *chinense* on S. *oryzae*. The study's findings demonstrated the insecticidal efficacy of the plant extracts against the test organism. The research findings indicate that the plants C. *chinense* and C. *odorata* had an impact on the rice weevil, S. *oryzae*. Nevertheless, the extract derived from both plants examined in this study did not exhibit a noteworthy disparity ($p>0.05$) when comparing the averages. An overall examination of the data regarding the efficacy of both treatments on the test organism (rice weevil) indicated a rise in the death rate between 24 and 72 hours. Additionally, the insect exhibited fast and erratic movements, displaying a tendency to flee from the Petri dish. As the concentration of the test organism grew over time, there was a corresponding rise in mortality. The ethanolic extract of both plants likely disrupted the regular respiratory processes of S. *oryzae*, leading to asphyxiation and mortality. This observation aligns with the previous investigations (Ashouri and Shayesteh, 2010), with similar experimentation.

The larvae of S. *oryzae* were destroyed by 56.7% and 76.8% at 3 and 7 days following treatment with C. *chinense* seed powder, respectively. Regardless of the duration of exposure, the findings of this investigation indicated that the whole plant extract of C. *chinense* exhibited higher toxicity and considerably elevated mortality rates (Ashouri and Shayesteh, 2010). The toxicity of C. *chinense* to S. *oryzae* may be attributed to the presence of many chemical compounds, including capsaicinoid, which consists of capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homodihydrocapsaicin, and homocapsaicin. A study conducted by Onunkun in 2013 has shown that plants from the Asteraceae family have repelling properties.

The foliage of C. *odorata* has been discovered to have pesticidal and repellent properties, as documented by Lawal *et al*. (2006) and Udebuani *et al*. (2015). The present study showcased the insecticidal efficacy of the entire plant extracts, which intensified as the length of exposure was prolonged. As per the research conducted by Onunkun (2013), it has been demonstrated that the leaf powder's ability to repel grew dramatically with longer exposure periods. The plant presumably contains poisonous phytochemicals, including as saponins, alkaloids, phenolics, flavonoids, and tannins, which are responsible for its insecticidal and repellent actions against S. *oryzae* in C. *odorata*. Studies have demonstrated that saponins possess distinct insecticidal properties, leading to elevated rates of mortality, decreased reproduction, reduced food consumption, and diminished weight in insects (DeGeyter 2012). This result aligns with research conducted by other scholars who utilized extracts from C. *chinense* and C. *odorata* as repellents for S. *oryzae* (Rajmohan and Logankumar, 2011; Ashouri and Shayesteh, 2010; Udebuani *et al*., 2015). Both plants possess medicinal properties and do not pose any harm to animals. To ensure food security in Nigeria, it may be necessary to integrate them with other pest management strategies.

Conclusion

According to recent research, the rice weevil (scientifically known as S. *oryzae*) can cause significant damage to all parts of the C. *chinense* and C. *odorata* plants during certain exposure periods. To ensure food security in Nigeria, it's crucial to handle these plants properly and incorporate them into pest management systems. However, the study also found that both plants have strong repellent and insecticidal properties, which make them effective in controlling and managing the rice weevil. As such, these findings suggest that using C. *chinense* and C. *odorata* plants could be a promising, environmentally friendly, and sustainable alternative to synthetic chemical insecticides that have negative impacts on the environment and human health.

References

Ashouri, S. and Shayesteh, N. (2010). Insecticidal activities of two powdered spices, black pepper and red pepper on adults of *Rhyzopertha dominica* (F.) and *Sitophilus granaries* (L.). *Munis Entomology and Zoology Studies*, 5 (2): 600-607.

Castillo, L., Jimenez, J. and Delgado, M. (2010). Secondary Metabolites of the Annonaceae, Solanaceae and Meliaceae families used as biological control of insects. *Tropical and Subtropical Agroecosystems* 12: 445-462.

Clemente, S., Mareggiani, G., Broussalis, A., Martino, V. and Ferraro, G. (2003). Insecticidal effects of Lamiaceae species against stored products insects. *Boletín de Sanidad Vegetal Plagas* 29: 1-8. Con 8: 1-11.

DeGeyter, E. (2012). Toxicity and mode of action of steroid and terpenoid secondary plant metabolites against economically important pest insects in agriculture. PhD dissertation, Faculty of Bioscience Engineering, Ghent University, Ghent.

Gallo, D., Nakano, O., Silveira Neto, S., Carvalho, RPL; Baptista, GC. de, Berti Filho, E., Parra, JRP., Zucchi, RA., Alves, SB. and Vendramin, JD. (2002). Entomologia Agrícola (*Agricultural Entomology*). Piracicaba, Fealq, 920.

Gnanamanickam, S.S. (2009) Rice and Its Importance to Human Life. Prog Biol.

Hernandez-lauzardo, A., Bautista-Banos, S. and Velazquez-Del Valle, M. (2007). Prospectiva de extractos vegetales para controlar enfermedades postcosecha hortofrutícolas. Revista Fitotecnia *Mexicana*, 2: 119-123.

Jeremy, T. (1990). Prospects of antifeedant approach to pest control. A critical review. *Journal of Chemical Ecology* 16: 3151- 3166.

Lawal N, Aggarwal, N. and Brar, D. (2006). Effects of different neem preparations in comparison to synthetic insecticides on the whitefly parasitoid *Encarsia sophia* (Hymenoptera: Aphelinidae) and the predator Chrysoperla carnea (Neuroptera: Chrysopidae) on cotton under laboratory conditions. *Journal of Pest Science*, 79: 201-207.

Lannacone, J. and Lamas, G. (2003). Efectostoxicológicos del nim, rotenona, cartapsobretresmicroavispasparasitoides de plagasagrícolasen el Perú. Boletín de Sanidad Vegetal. Plagas. 29: 123-142.

Moreggiani, G. (2001). Manejo de insectos plaga mediante sustancias semiquímicas de origen, *vegetal. Manejo Integrado de Plagas*, 60: 22-30.

Omokhua, A. G., Mcgaw, L. J., Finnie, J. F. and Staden, J. (2016). *Chromolaena odorata* (L.) R.M. King & Rob. (Asteraceae) in sub-Saharan Africa: A synthesis and review of its medical potential, *Journal of Ethnopharmacology*, 183: 112-122.

Onunkun, O. (2013). Studies on the repellent activities of four common Asteraceae in Nigeria against red flour beetle, *Tribolium castaneum*. *Journal of Pest Science*, 80: 110-117.

Oyedeji, A.A., Mariagoretti A. Buseri, Dorcas D.S. Bawo and Jasper F.N. Abowei (2020). Bio-control: Insecticidal activities of the methanolic extracts of *Garcinia kola* against cowpea bruchid (*Callosobruchus maculatus*). *Annals of Applied Science*, 6(1): 16-19.

Pascual-Villalobos, M. (1998). Repelencia, inhibición del crecimiento y toxicidad de extractos vegetales en larvas de *Tribolium castaneum* Herbst. (Coleoptera: Tenebrionidae). Boletín de Sanidad *Vegetal Plagas*, 24: 143-154.

Pinto, A. R., Furiatti, R. S., Pereira, P. R. V. S. and Lazzari, F. A. (1997). Avaliação de inseticidas no controle de *Sitophilus oryzae* (L.) (Col., Curculionidade) e *Rhyzopertha dominica* (F.) (Col., Bostrichidae) em arrozarmazenado (Evaluation of insecticides in the control of *Sitophilus oryzae* (L.) (Col.,Curculionidade) and *Rhyzopertha dominica* (F.) (Col., Bostrichidae) in stored rice). *Anais da Sociedade Entomológica doBrasil*, 26: 285-290.

Salvadores, Y., Silva, G., Tapia, M. and Hepp, R. (2007). Polvos de especias aromáticas para el control del gorgojo del maíz, *Sitophilus zeamais* Motschulsky, en trigo almacenado. *Agricultura Técnica*, 67: 147-154.

Puzzi, D. (1986). Abastecimento e armazenamento de grãos (Supplying and storing grains). São Paulo: Instituto Campineiro de EnsinoAgrícola, 191p.

Rajmohan, D; and Logankumar, K (2011). Studies on the insecticidal properties of *Chromolaena odorata* (Asteraceae) against the life cycle of the mosquito, Aedes aegypti (Diptera: culicidae). *Journal of Research in Biology*, 4: 253-257.

Santos, JP. (1993). Perda de peso em grãos armazenados devido ao ataque de insetos (Weight loss in the stores grains due to the insects attack). Sete Lagoas: Embrapa, CNPMS, 6p. (ComunicadoTécnico).

Subudhi PK, Sasaki T and Khush GS. (2006). Rice. In: Kole C, editor. Genome mapping and molecular breeding in plants. Berlin: Springer Verlag. pp. 1–78.

Timmer, C. Peter, Steven B, and David D, (2010). Long-run Dynamics of Rice Consumption." Prepared for the 50th Anniversary Volume of the International Rice Research Institute (IRRI), Los Banos, the Philippines.

Udebuani, A. C., Abara, P. C., Obasi, K. O. and Okuh, S. U. (2015). Studies on the insecticidal properties of Chromolaena odorata (Asteraceae) against adult stage of *Periplaneta americana*. *Journal of Entomology and Zoology Studies*, 3(1): 318-321.

Uyi, OA., Opoku, AR. and Ogunwande, IA. (2015). Phytoconstituents and insecticidal activity of different solvent leaf extracts of Chromolaena odorata L., against *Sitophilus zeamais* (Coleoptera: Curculionidae). *European Journal of Medicinal Plants*, 5(3): 237-247.

Valladares, G., Garbin, L., Defago, M., Carpinella, C. and Palacios, S. (2003). Actividadantialimentaria e insecticida de un extracto de hojassenescentes de Melia azedarach (Meliaceae). *Revista de la Sociedad Entomológica Argentina*, 62: 53-61.

Viglianco, A., Novo, R., Cragnolini, C. and Nassetta, M. (2006). Actividad biológica de extractos crudos de *Larrea divaricata* Cav. y *Capparis atamisquea* Kuntze sobre *Sitophilus oryzae* (L.). *Agriscientia* 23: 83-89.