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EFFECTIVENESS OF BOTANICAL PREPARATIONS FOR THE CONTROL OF RICE WEEVIL (*SITOPHILUS ORYZAE*) DURING RICE SEED STORAGE AND THEIR IMPACT ON THE RICE SEED VIABILITY.

A thesis presented in partial fulfilment of the requirements for the degree of

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ALIEU MORTUWAH SARTIE

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Errata

Page vi:	LIST OF TABLES: Change x to ix-x LIST OF FIGURES: Change x-xi to x
Page 3, line 3	delete "such as Malathion", move (Hill, 1987) to after "... in the environment".
Page 4, item 3:	Change botanical to botanicals, and delete "extracts".
Page 5, lines7 and 8:	Add Linnaeus to *O. sativa* and Steudel to *O. glaberrima* as authorities i.e. *Oryza sativa* (Linnaeus) and *Oryza glaberrima* (Steudel).
Page 10, line 6:	Change *Rhyzopertha domonica (Fabricicus)* to *Rhyzopertha dominica (Fabricius).*
Page 14, line 3-5:	Change sentence to read "Fumigation is still one of the most effective methods for disinfesting stored food, feedstuff and other agricultural commodities from insect infestation but gives no lasting protection".

Page 17,para 3, line 10:Add "abrasive" in front of powders and dusts.

Page 17 bottom line:	Change poses to possess.
Page 36 4.2.3:	Change "Effect of storage time on weevil mortality" to "Effect of storage time of treated rice seed on adult weevil mortality"

Alieu Mortuwah Sartie.

Abstract

Food security and the maintenance of seed quality from harvest to planting are key issues for peasant farmers. In Sierra Leone, up to 28% of rice seed can be damaged by rice weevil in the six months storage period. The use of chemical insecticides to control this insect is not practical for traditional farmers. Some tribes use pepper powder (*Capsicum spp.*) as a seed protectant. In this study, I have compared the effects of neem (*Azadirachta indica*) oil, neem powder, pepper (*Capsicum frutescens* cv. "Habanero") powder and lentil (*Lens culinaris* cv. "Raja") powder on the survival of adult rice weevil (*Sitophilus oryzae*) and weevil offspring during rice (*Oryza spp.*) seed storage, and on the germination of the rice. Treatment of stored rice with neem oil, neem powder and lentil powder gave some protection from rice weevil damage. Neem oil at the rate of 0.005ml/kg rice seed effectively controlled weevil damage without reducing the seed germination. Lentil and neem powders at the rate of 0.02g/kg rice seed gave effective protection against rice weevil damage with no reduction in viability of the seeds. Pepper powder did not kill adult rice weevil. Neem oil reduced the development of weevil offspring in rice seed, but the powders of neem, lentil and pepper did not. Low relative humidity of 42.5% in seed storage environment and a reduction in seed moisture content below 10% enhanced the mortality of adult rice weevils on rice seed.

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"Ask, and you will receive; seek, and you will find; knock, and the door will be opened to you. For everyone who asks will receive, and anyone who seeks will find, and the door will be opened to those who knock".
Matthew 7: 7- 8 Good News Bible.

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DEDICATION

This work is dedicated to my father, Mr. Moinina Sartie and my mother, Mrs. Mattu Jeneba Sartie for the many tribulations they went through to put me on the academic ladder. I pray that they will live long to enjoy the fruit of their labour.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

1

INTRODUCTION

1.1 Importance of rice

Rice (*Oryza spp.*) is one of the most important food crops of the world, and is produced on all continents. In-fact, it is the most important food for mankind (Way and Bowling, 1991). It was an important food even before the dawn of written history (Adair, 1972). However, a comparatively small amount of rice moves in world trade because a high percentage of the world rice crop is consumed in the countries where it is produced. Annual world rice production amounts to approximately 563 million metric tons (t) grown on roughly 150 million ha (FAO, 1998). The average annual amount of rice in world trade is just over 28 million t (FAO, 1998), less than 5% of the total world production.

The area of rice production is second only to the area devoted to wheat, but in terms of importance as a food crop, rice provides more calories per hectare than any other cereal crop (McDonald and Copeland, 1997). The world rice crop area is only about 58% as much as that for wheat. However, the average yield of rice is much higher than for wheat, so that the total world production of rice is only about 6% less than for wheat. Over 95% of the world production of rice is used for human food (Adair, 1972).

Rice is the principal cereal food in Asia and some countries in Africa and Latin America. It is used as a food in all countries in the world (Adair, 1972). Rice is the staple food for more than half the world's population, mostly in Asia countries (Alam, 1970). Although it is the staple food, or fast becoming so, in most West African countries, scarcely any are self-sufficient in rice. Demand is increasing faster than production, mainly due to use by an expanding urban population and ease of cooking and storage (WARDA, 1994).

In Sierra Leone, rice is the staple food grown by more than 95% of rural families. However, domestic rice production fell from 508,000t in 1989-91 to 411,000t in 1998 (FAO, 1998). Imported rice is estimated to represent an average of 20% of total

consumption (120,000t in 1991) and the last year of rice export was 1953. Rice importation has been on the increase since 1980 from 62,119t to 243,200t in 1995 (FAO/GIEWS, 2000). This trend is continuing. The area under rice in 1999 was restricted mainly by shortages of rice seeds. In some cases, the quality of seeds was also very poor (FAO/GIEWS, 2000).

Dichter (1976) estimated that in sub-Saharan regions of Africa, losses of food grains during storage at farm or village level can amount to 25-40% of the harvested crops. This wastage of food is unacceptable when so many people in Africa remain hungry.

Rice cultivation is being promoted by national and international organisations but increased production currently comes from expansion of the cultivated area and not from higher yields per unit area. Rice yields in West Africa are well below the world average of 3.7 t/ha, due to a combination of production economics, limited research impact and the complexities of the rice growing environment (WARDA, 1994).

1.2 Control problem in insect pests

Insect pests are a serious limiting factor in rice production which must be protected and increased to foster human health and world peace and stability (Cogburn, 1991). The rice weevil, (*Sitophilus oryzae*) is the most destructive pest of stored grain in the world (Bhuiyah *et al.*, 1990), and is one of the most serious pests of stored rice, especially in the tropics where it causes tremendous losses (Grist and Lever, 1969). It causes about 5–28 % storage loss of seed rice in northern Sierra Leone (Sartie, unpublished, 1998). Adult weevils feed mainly on the endosperm, reducing the carbohydrate content and the larvae feed preferentially on the germ of the grain, thus removing a large percentage of the protein and vitamins (Bello et al., 2001).

The use of pesticides to control rice weevil has not been very successful as most farmers are too poor to pay the costs of these chemicals, and insects readily develop resistance to the chemicals (Champ, 1968; Lale, 1995; Arthur, 1996)). In addition, the chemicals are hazardous to their users (Ecobichon *et al.*, 1990) and may also leave harmful residues in

food commodities (Lale, 1995). The long-term cost of using insecticides is inestimable when the possible effects of pollution are considered. Pollution poses a problem to human health since some pesticides, such as Malathion, persist in the environment and can be accumulated in our tissues with multiple, unpleasant and even lethal consequences (Hill, 1987). For this reason, some pesticides such as DDT have been banned from many countries. When an insecticide is first used it may be very effective but, over the years, becomes less so if insects become resistant to it. Repeated use of single chemical on one target pest increases the likelihood of resistance developing. With the present rate of use, many insect pests may before long become resistant to all known pesticides (Kumar, 1984). Management of resistance is one of the most pressing problems of modern pest control (Kumar, 1984). According to the WHO (1976), resistance is probably the biggest single obstacle in the struggle against vector-borne diseases and is mainly responsible for preventing successful malaria eradication in many countries. According to Georghiou and Taylor (1977), the number of species of insects and acarines in which resistant strains have been reported has increased from 1 in 1908 to 364 in 1975.

Pesticides may also kill non-target species. The use of pesticides in the attempted control of cocoa mirids has resulted in killing of a number of key stone parasites and predators of the pest. This has probably contributed to the emergence of a new pest of cocoa, the shield bug *Bathy coeha* which is reported to cause an 18% loss in the yield of cocoa in the Eastern and Brong-Ahafo regions of Ghana (Owusu-Manu, 1971).

As a result of these problems with synthetic chemicals, there has been a renewed interest in the use of natural plant products in the protection of stored agricultural products against weevils. Most of these natural products, especially the edible ones, are relatively safe, cheap and readily available in the tropics (Lale, 1995) and also in temperate regions. The use of natural plant products has been reported successful in the control of rice weevil in stored maize and wheat (Su, 1977; Ivbijaro, 1983b; Abdel-Kawy and Gharib, 1992), but their role in controlling weevil during rice seed storage is not clear.

1.3 Objectives

The objectives of this research were;

1. To assess the effectiveness of using the natural plant products like neem oil, neem powder, lentil seed powder and pepper powder to control adult rice weevil during rice seed storage.
2. To determine the effect of the botanicals on the development of rice weevil offspring.
3. To determine the effect of these botanical extracts on the viability of the rice seed.