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Seed coat and variety of peanut inhibits host preference and development of *Oryzaephilus mercator*

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ABSTRACT

Oryzaephilus mercator (Fauvel) (Coleoptera: Silvanidae) is a postharvest pest of stored peanuts (*Arachis hypogea* L.). Although it is only a secondary pest, this insect causes extensive damage and reduces the quantity and quality of peanut kernels. The objective of this research was to study whether host preference and development of *O. mercator* differ depending on the variety of peanut and/or on whether the peanut retains its seed coat or is bare. We used three varieties of peanut (Kelinci, Bison and Takar1) separating out each variety into groups with or without a seed coat. In the laboratory, we conducted two separate studies examining host preference and development of *O. mercator*. Host preference was studied using a preference cage consisting of six chambers for all peanut varieties with and without seed coat and each cage contained 15 mating pairs of *O. mercator*. The development study was conducted by placing 15 mating pairs of *O. mercator* into a treatment jar and allowing them to feed on different peanut varieties with and without a seed coat. Results from the host preference study indicated that *O. mercator* preferred bare kernels of the Kelinci variety over other peanut varieties both as a food source and for oviposition. During the development experiment, we observed that *O. mercator* experienced faster development time when exposed to bare kernels of all three varieties tested as opposed to those with intact seed coat. Results show that peanuts with a seed coat and variety with high kernel hardness (Bison variety) deters predation and inhibits host preference and development of *O. mercator*.

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1. Introduction

Pest infestation in storage is detrimental because it can reduce the quality and quantity of agricultural products. In tropical and subtropical areas, the yield loss due to postharvest pest attack can reach 50% (Wilbur, 1971). One of the most common storage pests worldwide is *Oryzaephilus mercator* (Fauvel) (Coleoptera: Silvanidae). *O. mercator,* also known as the merchant grain beetle, is a cosmopolitan pest that is found in a broad range of stored products (Curtis and Clark, 1974; Hill, 1994). This insect pest is widely distributed and feeds on a wide variety of grains and processed foods (Hill, 1994; Komson, 1968). As a storage pest, *O. mercator* is considered a secondary pest, less important than *Oryzaephilus surinamensis* (L.) (saw-toothed grain beetle). *O. mercator* generally attacks products that have already been infested by primary pests such as *Rhyzopertha dominica* (F.) (Coleoptera: Bostrichidae), the lesser grain borer (Rees, 2004). *O. mercator* is able to gain access to already processed and packaged stored products due to its flat shape and small size (Rees, 2004).

In Indonesia, *O. mercator* infestation was first reported in stored nutmeg (*Myristica fragrans*). This beetle then spread to become an important pest of grains and seeds, copra, and cacao (Kalshoven, 1981). *O. mercator* prefers foods with high oil content, such as grains and grain products, oilseeds and nuts, but also will eat herbs and spices as well as dried fruits (Rees, 2004, 2007). Peanuts (*Arachis hypogea* L.) are a preferred host of *O. mercator* and the crop suffers high economic losses due to infestation (Rao et al., 2010). Because it is an important commodity in Indonesia, the nation has sought a solution to the problem of *O. mercator* infestation, particularly in the storage management. Peanut production in Indonesia decreased greatly from 779,228 ton in 2010 to 605,449 ton in 2015 (BPS-Statistics Indonesia, 2016) with postharvest pest attacks representing one of the main contributing factors of this decline. Consequently, a number of studies have been conducted on how to prevent and control *O. mercator* infestation of goods in storage, investigating bioecological and other factors that influence the severity of damage from this pest.

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Population and infestation rates of *O. mercator* may be affected by the physical and chemical characteristics of potentially-targeted foods. Physical characteristics includes the inherent structure and status of the food (e.g. size and hardness of kernel), while chemical characteristics describes the constituent compounds contained (e.g. ash, protein, fat and carbohydrate) within target foodstuffs (Fouad et al., 2013). Attention to both of these factors is necessary to understand especially to prevent and control *O. mercator* attack on stored peanuts. Different varieties of peanuts have different nutritional content which may affect host preference. In addition, the physical condition of peanuts may differ not only in terms of inherent properties but in accordance with different levels of processing. In general peanuts are shelled before storage, but some peanut kernels are stored with seed coat intact, while others are stored without the seed coat (bare kernels). Both nutrient content and physical condition of stored peanuts can have an effect on the incidence of storage pests. Peanut kernels without an intact seed coat are generally more susceptible to physical damage and pest attack.

Research about host preference and development of *O. mercator* in relation to stored peanuts is still lacking. Thus, there is insufficient knowledge to be used as a recommendation in integrated pest management and peanut breeding programs for *O. mercator*. The objective of this research was to study host preference and development of *O. mercator* when exposed to kernels of three varieties of peanut with and without a seed coat.

2. Material and methods

2.1. Insect rearing

A hundred specimens of *O. mercator* adults were collected from macadam nuts (*Macadamia* sp.) taken from the storage and were introduced into a small jar containing 80 g of feed primarily consisting of shelled hazelnuts (*Corylus avellana*) (adapted from Beckel et al., 2007). The adult insects were exposed for seven days and allowed to lay eggs. After seven days, all adults were removed from the jar, leaving behind the eggs laid by the adults. Food was replenished in the jar and the eggs were allowed to develop into new adults (F_1 progeny). Based on procedures developed by Heinrichs et al. (1985), F_1 progeny aged 7–14 days were used for our experiments.

2.2. Preparation of peanuts for the experiment

For our experiments we used three varieties of peanut i.e. Kelinci, Bison, and Takar1 that were obtained from the Bean and Tuber Research Institute (Balitkabi), Malang. The Kelinci and Bison varieties were selected because they are commonly cultivated by farmers in Indonesia, while the Takar1 variety is not yet widely cultivated but has commercial potential due to its large pod size. In addition to comparing different peanut varieties, we also studied the effect of removing the kernel seed coat, versus leaving the seed coat intact.

Before utilizing them in our experimental treatments, all peanuts were kept in a freezer at −15 °C for one week, to sterilize them and to eliminate insect infestations by killing insects of any stage that may be present in the samples. After one week, the kernels were removed from the freezer and refrigerated at 5 °C for another week to kill of any possible remaining insect infestation. Finally, the sterilized kernels were kept at room temperature (27 ± 2 °C) for 14 days for acclimatization before use in our experimental treatments (adapted from Heinrichs et al., 1985).

After sterilization, each peanut variety was also analyzed for chemical and physical characteristics. Chemical analysis was measured using proximate analysis to determine the basic nutritional content of each variety, including proportions of carbohydrate, protein, fat, water and ash. Physical analysis included measurement of seed hardness and thickness of the seed coat (Table 1). Each variety of peanut was also characterized according to surface morphology of seed coat using scanning electron microscope (Fig. 1).

2.3. Host preference tested on three varieties of peanut

The study used completely randomized design and was repeated four times. Host preference studies were conducted in preference cages consisting of six chambers (Fig. 2), with 3 chambers containing a particular peanut variety with seed coat intact, and the remaining 3 chambers containing those same varieties with seed coat removed. Each chamber in the preference cage contained 30 g of each variety/seed coat combination (sterilized) and then 15 mating pairs of *O. mercator* adults aged between 7 and 14 days were placed in the center of the cage. The adults did not have access to food 24 h before introduction into the preference cage (adapted from Heinrichs et al., 1985).

After introduction of the adults, the preference cage was wrapped in gauze material to prevent the escape of *O. mercator*, as well as avoid contamination/infestation by other insects. The adults were left in the preference cage for 7 days, to allow time for *O. mercator* oviposition. On day 2 and day 7 after the initial introduction of *O. mercator*, we measured the number of adults present (feeding preference) in each chamber (for each variety/seed coat combination). We measured the number of eggs (oviposition preference) only once, on day seven.

2.4. Development tested of O. mercator on three varieties of peanut

The experiment used completely randomized design and was repeated four times. For each treatment, a tube (d = 6.5 cm,

Table 1
Physical and chemical characteristics of three peanut varieties.

Variety	Physical characteristics		Chemical characteristics				
	Seed hardness (Newton)	Seed coat thickness (mm)	Carbohy- drate (%)	Protein (%)	Fat (%)	Water (%)	Ashes (%)
Kelinci							
w/seed coat	83.917	0.064	21.14	25.05	46.04	5.36	2.41
w/o seed coat	89.040	na	22.96	21.94	47.27	5.58	2.25
Bison							
w/seed coat	126.102	0.054	22.10	27.18	43.39	5.01	2.32
w/o seed coat	49.925	na	23.97	24.46	43.52	5.81	2.24
Takar1							
w/seed coat	105.947	0.092	16.10	24.52	51.62	5.23	2.53
w/o seed coat	68.042	na	16.57	22.08	53.65	5.32	2.38

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