The mean time of choice of the two alternatives was recorded and compared with t-test. *P. interpunctella* larvae took more time than Coleoptera to choose, the mean time of choise of the preferred substrate for Coleoptera was respectly 3.21 minutes for *T. confusum* and 1.63 minutes for *O. surinamensis*, only the mean choice time of *T. confusum* between organic litter and breeding substrates was statistically significant for $p<0.05$ (t-test) (table 5).

Tab. 5 Mean time used by insects in chosen the test substrate (organic litter). Means followed by "*" are significantly different ($p<0,05$) than the response to the control (t-test).

Test insect	Choice time (min)	
	T-Organic litter	TNT-Breeding substrate
Plodia interpunctella	11,67	12,76
Tribolium confusum	5,00*	3,21
Oryzaephilus surinamensis	1,75	1,63

4. Discussion

The results obtained show that the test insects in front of a choice between a balanced diet substrate and a commercial litter, prefer the first substrate. This result complete and integrate the information available in literature (Phillips *et al*., 1994, TsuJi, 2000, Mowery *et al*., 2002). These data are preliminary and require further investigations on the possible attractiveness of organic litter compared to other commodities stored in pet food shops by other stored food pest or its attractiveness in interaction with other volatile components.

References

World Bank, FAO, NRI, 2011: Missing Food: the Case of Post-harvest Grain Losses in Sub-Saharan Africa. In: Economic Sector Work Report No. 60371-AFR. WorldBank, Washington, DC.

Roesli, R., Subramanyam, B., Campbell, J. F., & Kemp, K., 2003: Stored-product insects associated with a retail pet store chain in Kansas. Journal of Economic Entomology, 96(6), 1958-1966.

Loschiavo, S. R.; okumura, G. T. 1979: A survey of stored product insects in Hawaii.

Platt, R. R., Cuperus, G. W., Payton, M. E., Bonjour, E. L., & Pinkston, K. N., 1998: Integrated pest management perceptions and practices and insect populations in grocery stores in south-central United States. Journal of stored products research, 34(1), 1-10.

Wakefield, M. E., Bryning, G. P., Collins, L. E., & Chambers, J., 2005: Identification of attractive components of carob volatiles for the foreign grain beetle, Ahasverus advena (Waltl):(Coleoptera: Cucujidae). Journal of stored products research, 41(3), 239-253.

Phillips, t.w., strand, m.r., 1994: Larval secretions and food odors affect orientation in female Plodia interpunctella. Entomologia Experimentalis et Applicata 71, 185–192.

Tsuji, hideakira, 2000: Ability of first instar larvae of the Indian-meal moth, Plodia interpunctella Hubner, to reach their food. *Medical Entomology and Zoology*, 51.4: 283-287.

Mowery, S. V., Mullen, M. A., Campbell, J. F., & Broce, A. B., 2002: Mechanisms underlying sawtoothed grain beetle (Oryzaephilus surinamensis [L.])(Coleoptera: Silvanidae) infestation of consumer food packaging materials. Journal of economic entomology, 95(6), 1333-1336.

Evaluation of the difference in the development of stored insect pests on organic litter

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Abstract

On July 2017 in a warehouse of pet food shop in Italy an infestation of *Oryzaephilus surinamensis* was found on a pallet of organic litter, near an infested pallet of dog's pasta. In order to investigate the origin of the infestation, and to support the risk assessment by the pest control operator, one test was conducted at Agroblu Laboratory of Applied Entomology (LEAA) to observe the feasibility of development of *O. surinamensis*, *Plodia interpunctella* and *Tribolium confusum*, in a substrate of 2,5 g of organic litter and to compare it to a balanced diet substrate.

The results showed that only *T. confusum* was able to develop with no statistical difference both on the breeding diet and the organic litter.

Keywords: stored food pest insects, organic litter, *Plodia interpunctella*, *Tribolium confusum*, *Oryzaephilus surinamensis*

1. Introduction

The stored food insects have a high economical importance because of they contribute to the post harvest losses around 16% (World Bank et al., 2011). Food industries pest are also involved in losses in pet food industries. A limited number of surveys were conducted to determine insect species associated with retail grocery, and pet stores, however there are some experience that record the presence in warehouses and in the pet food stores of the common stored pest insects (Loschiavo and Okumura, 1979; Platt et al., 1998, Roeslli et al., 2003). This autor reported that the common species recorder in a pet store were *Plodia interpunctella* (Hübner), *Oryzaephilus mercator* (Fauvel), *Tribolium castaneum* (Herbst) and *Sitophilus* spp.

In a pet store, stored pest food can cause damage to various preserved animal feeds and to another commodity that is rarely considered, such as the increasingly popular organic litter for cats, hamsters, reptiles and amphibia. Organic litter is composed of bran, flours and other residues of the screening of corn that may result attractive to the same pest insects. On July 2017, an infestation by *O. surinamensis* of a package of dog's pasta has been reported in a pet food store. The origin of infestation was investigated and was discovered it had developed from a pallet of ecological litter for pets. Thanks to these events, the aims of the present work is to investigate the development faeseability for *O. surinamensis*, *P. interpunctella* and *T. confusum* on organic litter in comparison with a balanced diet.

2. Materials and Methods

2.1 Insects

The insects used in the test was provided by the Agroblu Laboratory of Applied Entomology (LEAA) placed in Via Isonzo 20, Rozzano Milan, where are rearing at 26 ± 2 °C 70% RH and photoperiod light darkness 16L:8D.

The test organisms used were typical insects infesting food industries and also collected in pet stores.

For the test were employed eggs 72 h laid of *Plodia interpunctella* (Hübner), adult stage of *Tribolium confusum* (Jaqcquelin du Val) and *Oryzaephilus surinamensis* (Linnaeus). Table 1 reported the species and stage used for the test.

Tab. 1 Species, stages and substrates used for the test.

Insect	Stage	Quantity	Substrate TNT	Substrate T
P. interpunctella	Eggs 72 h laid	50	Honey, glycerin, white flour, semolino, yellow flour, oatmeal, sesame, bran	Organic litter
T. confusum	Adult	10 adults	Semolino, brewer's yeast, bran	Organic litter
O. surinamensis	Adult	10 adults	Honey, glycerin, white flour, semolino, yellow flour, oatmeal, sesame, bran	Organic litter

2.1 Substrates

The test was conducted to compare the level of development on organic litter with a substrate normally used for breeding. *P. interpunctella* and *O. surinamensis* were reared on a diet composed as follow honey 15%, glycerin 5%, white flour 20%, semolina 20%, yellow flour 15%, oatmeal 5%, sesame 15%, bran 5%.

T. confusum diet was composed 70% semolina, 29% bran and 1% brewer's yeast.

The composition of the organic litter, vegetable granules, obtained by extracting and drying the fibrous part of the corn's ear, was reported in table 2

Tab. 2 Composition of organic litter.

Component	Range
Raw ashes	1 – 2%
Raw protein	0,5 – 1,5%
Raw lipidis	0,1 – 1%
Raw fiber	33 – 40%
Extraction inazotati	50 – 60%
Moisture	4 – 10%.

2.3 Test unit

The substrates whit the test species were put into small plastic container 6 cm diameter and 6,5 cm high. The container was covered with a plastic twist cap provided with a small hole 1cm diameter, covered with a special filter that avoid the escape of insects and allow the air exchange.

2.4 Test site

The test was conduced in the Peet Grady room of LEAA at 26° ± 2 °C 70% RH and photoperiod light darkness 16L:8D in 4 replicates.

2.5 Application method

2.5.1 Lepidoptera

For the test with *P. interpunctella* the eggs were collected from breeding and examineted at the stereo-microscope to verify their integrity and to exclude the presence of mites. After the check, 8 groups of 50 eggs were sorted each in one plastic container four of which were filled with the balanced diet (TNT) and the other four have been filled with organic litter (T) to give the possibility to the newborn larve to feed.

2.5.2 Coleoptera

For *O. surinamensis,* 8 groups with 10 adults were sorted in 8 plastic containers 4 with balanced diet (TNT) and 4 with test substrate. For *T. confusum* 10 new born larvae per group were arranged as above.

2.6 Evaluation method

After the start of the test, the experimental units were checked every seven days and the development stage of the test species at the time of the assessment was noted. In according to the scale shown in table 3 the qualitative data was converted in number for statistical analysis.

Tab. 3 Table of conversion for data analysis.

Index	Stage achieved (at least one individual)
0	No development
1	Newborn larvae
2	Mature larvae
3	Pupae
4	Adults

The obtained data was statistically elaborated with t-test. For all test species the test was stopped at the appearance of adults.

2. Results

The results showed a difference in development in all the species. Only *T. confusum* showed the ability to complete the life cycle to organic litter successfully. The table 4 below showed the results observed.

Tab. 4 Table of results (mean of four replicates). Means followed by "*" are significantly different (p<0,05) than the response to the control (t-test).

P. interpunctella	***T. confusum***	***O. surinamensis***

	T	TNT	T	TNT	T	TNT
T 1	0	0,25	2	2,5	0	0
T 2	0,25*	1	2,75	2,5	0*	3,25
T 3	0,25*	1,5	3,5	3,75	0*	2,75
T 4	0,5*	2	4	4	0*	2,5
T5	0,5*	3,25	4	4	0,25*	4

P. interpunctella was not able to develop on organic litter, indeed young larvae failed to develop in any replicates. *O. surinamensis* too showed difficulties in develop on organic litter and only one adult emerged by one replicates in all the test.

T. confusum showed a significative difference in development only in the first assessment. The following assessments showed no significant difference to the control.

3. Discussion

These data confirmed and integrated the avaible information in literature about the influence of diet on development of stored pest, with reference to *P. interpunctella* and *O. surinamensis* (Fields *et al.*, 1992; Johnson *et al.,* 1995, Hagstrum and Milliken, 1988; Waldbauer and Bhattacharya, 1973).

With reference to *T. confusum*, this study showed that it was able to complete successfully his development on organic litter. These data are preliminary and require further investigations on the possible development on organic litter by other stored food pest in addition to adjustments to the experimental protocol.

References

World Bank, FAO, NRI, 2011: Missing Food: the Case of Post-harvest Grain Losses in Sub-Saharan Africa. In: Economic Sector Work Report No. 60371-AFR. World Bank, Washington, DC.

ROESLI, R., SUBRAMANYAM, B., CAMPBELL, J. F., & KEMP, K., 2003: Stored-product insects associated with a retail pet store chain in Kansas. Journal of Economic Entomology, **96.6**: 1958-1966.

LOSCHIAVO, S. R.; OKUMURA, G. T., 1979: A survey of stored product insects in Hawaii.

PLATT, R. R., CUPERUS, G. W., PAYTON, M. E., BONJOUR, E. L., & PINKSTON, K. N., 1998: Integrated pest management perceptions and practices and insect populations in grocery stores in south-central United States. Journal of stored products research, **34.1**: 1-10.

FIELDS, P.G., 1992: The control of stored-product insects and mites with extreme temperatures. Journal of Stored Products Research **28**: 89–118

JOHNSON J. A., WOFFORD L., AND GILU R. F., 1995: Developmenental Thresholds and Degree-Day Acclunulations of Indianmeal Moth (Lepidoptera: Pyralidae) on Dried Fruits and Nuts J. Econ. EntomoL **88.3**: 734-742.

WALDBAUER, G. P.; BHATTACHARYA, A. K., 1973: Self-selection of an optimum diet from a mixture of wheat fractions by the larvae of Tribolium confusum. Journal of Insect Physiology, **19.2**: 407-418.

HAGSTRUM, DAVID W.; MILLIKEN, GEORGE A., 1988: Quantitative analysis of temperature, moisture, and diet factors affecting insect development. Annals of the Entomological Society of America, **81.4**: 539-546

Unusual cases of product contamination by 'wandering' larvae of the Indian meal moth, *Plodia interpunctella* (Lepidoptera: Pyralidae)

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ABSTRACT

Upon hatching, the larvae of the Indian meal moth (IMM), *Plodia interpunctella*, disperse vigorously. Within a few hours, they establish themselves on the crevices of food or enter packaged product through small openings and cracks. When on food the larvae intensively feed in or near a tunnel-like case made of frass and silk they web together. The number of larval instars varies from five to seven, depending on temperature, humidity and available food quality. Most mature larvae leave the food medium and search for a suitable place to spin a cocoon in which they pupate or hibernating (diapause). At the end of larval development, the larvae usually chews a hole in a packaging foil, and leave the medium to pupate outside in corners and cracks and also behind