9th International Seminar of Research Month 2024
Volume 2025
http://dx.doi.org/10.11594/nstp.2025.4730

NST Proceedings
OPEN ACCESS

Conference Paper

Characterization of Artificial Feed for Armyworms (*Spodoptera frugiperda*) as a Support for Pest Control Technology Research

Dita Megasari[1]*, Dita Atasa[1], Denia Rista Damayanti[1], Aliyatul Najiyah[1], Oktaviana[1], Arman Adrian Maulana[1], Syaiful Khoiri[2]

[1]Faculty of Agriculture, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya 60294, Indonesia
[2]Faculty of Agriculture, Universitas Trunojoyo, Bangkalan 69162, Indonesia

Corresponding author:
E-mail:
dita.megasari.agrotek@upnjatim.ac.id

ABSTRACT

Spodoptera frugiperda is one of the pests known for its ability to cause quite severe damage to cultivated plants, so research related *to S. frugiperda* is the focus of research both on a field and laboratory scale. Laboratory-scale *S. frugiperda* research is generally carried out by keeping target insects as research materials in large quantities. The use of natural feed in insect maintenance often experiences limitations, so artificial feed is developed for *S. frugiperda*. This study was conducted to determine the characteristics of the artificial feed being developed. The research method is a qualitative method with parameters of color observation, weight per 100 grains, dry weight, and wet weight in three artificial feed formulas that were developed. The results of the study showed that in formulas one and two, the color of the feed was brownish green, while formula three was light brown. The weight per 100 grains of artificial feed showed that formula one had the highest weight and formula three had the lowest weight. The highest dry weight and wet weight were obtained in Formula 2, while the lowest weight was obtained in Formula 3. The conclusion that can be drawn from this study is that the characteristics of artificial feed for S. frugiperda, including color, weight per 100 grains, dry weight, and wet weight of the feed, are influenced by the formulation of the artificial feed.

Keywords: Artificial feed, Spodoptera frugiperda, feed characterization, formulation

Introduction

Originating in tropical and subtropical regions of the Americas, *Spodoptera frugiperda* is an invasive species that threatens corn crops' ability to feed people. Due to its polyphagous nature, *S. frugiperda* is a serious threat to the presence and population growth of food plants belonging to the Gramineae family, including corn, rice, wheat, sorghum, and sugarcane. According to CABI (2019), *S. frugiperda* infestations can result in yield losses of up to 55%. Total losses caused by this pest in Africa and Europe range from 8.3 to 20.6 million tons yearly, translating into economic losses estimated at US$ 2.5 to 6.2 billion. This statement is supported by Lestari et al., (2013) who mentioned that *S. frugiperda* is one of the insects that damage crops, but is also often needed in insect pest control research in the laboratory. The same source also states that information regarding the mortality rate, fecundity, sex ratio, population growth rate within one generation, reproductive potential, and life cycle of *S. frugiperda* needs to be known for the maintenance of this pest in the laboratory.

Studies related to both chemical and biological insecticides continue to be developed to control the armyworm pest. According to Ambarningrum (2001), the use of insecticides must still

How to cite:
Megasari, D. et al. (2025). Characterization of artificial feed for armyworms (Spodoptera frugiperda) as a support for pest control technology research. *9th International Seminar of Research Month 2024*. NST Proceedings. pages 195-200. doi: 10.11594/ nstp.2025.4730

consider environmental impacts and support the sustainability of predators. This underlines the importance of cultivating armyworms, which can be continued with further large-scale research. This research requires a large number of insects for various treatments in the laboratory, so they must be available continuously. This is supported by the research of Sudrajat et al., (2020), where artificial feed has been commonly used for the mass rearing of many insect species, both for research and commercial purposes. Oomen (1982) claims that food is important for maintaining the protein and energy needed by the insect for its many bodily functions, for healing injured tissue, and for controlling the sustainability of both environmental factors and processes.

The use of natural feed as nutrition for insects often faces limitations because it requires time that coincides with the growth of the insects, making its availability often insufficient. Additionally, natural feed is influenced by many factors that can affect the results. The production of artificial feed derived from the main raw materials of insects needs to pay attention to the quantity and quality contained, including ascorbic acid, yeast, carbohydrates, proteins, plant materials, lipids, sterols, preservatives, sorbic acid, benzoic acid, sodium sulfite, sodium bisulfite, chlorine chloride, and antibiotics (Susrama, 2017).

Raw materials are the main factor that must be available in the production of artificial feed. Raw materials can generally be classified into two major groups: those derived from plants and their by-products (vegetable) and those derived from animals and their by-products (animal). Vegetable raw materials are those that come from plants or parts of plants; they are generally a source of carbohydrates and are also rich in protein and vitamins. On the other hand, animal raw materials are those that come from animals or parts of animal bodies (Kartasudjana & Suprijatna, 2006).

The artificial feed used to rear insects in the laboratory can enhance knowledge about the biology, behavior, and nutritional needs of insects. Artificial feed must still pay attention to the balance of nutritional components in terms of both quality and quantity. According to Maldonado (2011), good artificial feed is characterized by a larval viability of over 70%, a shorter larval stage duration, fewer instars, and greater weight of larvae and pupae. The nutritional composition contained in artificial feed consists of ascorbic acid as an antioxidant and phagostimulant, yeast as a source of protein, carbohydrates as an energy source, protein, plant materials, lipids, sterols, preservatives, sorbic acid, benzoic acid, sodium sulfite, sodium bisulfite, additives, chlorine chloride, and antibiotics.

Material and Methods

The research was conducted from May to August 2024 at the Plant Health Laboratory, Faculty of Agriculture, Universitas Pembangunan Nasional "Veteran" Jawa Timur. The tools used in this research include an insect rearing box, microscope, tweezers, petri dishes, cotton, wire, plastic string, plastic trays, scales, stationery, documentation tools, oven, and feed printing machine. The materials used are Madura 3 variety corn plants, *S. frugiperda* larvae, distilled water, honey, labels, polybags, soil, manure, and the composition of artificial feed ingredients.

The artificial feed used in this study is a modification of Nalim and Parra (1991). The artificial feed is made by boiling 240 grams of mung beans with 500 ml of distilled water for 20 minutes and then cooling it down. The boiled mung beans are then mixed with cornstarch and blended. 20 grams of agar is boiled with 500 ml of distilled water until it reaches a boil, after which the solution is cooled to 60°C and then blended until smooth. The two solutions were then mixed and 72 grams of yeast, 7.3 grams of ascorbic acid, 2.4 grams of sorbic acid, 4.4 grams of nipagin, 10 ml of vitamin solution, and 6 ml of formaldehyde (40%) were added and then blended again until smooth. The final solution is then cast into a mold for artificial feed. The formulation being evaluated is the feed ration with the substitution of corn flour. The composition of the artificial feed is outlined in Table 1. The observation parameters include color, weight per 100 grains, moisture content, and the hardness of the feed or resistance to impact.

Table 1. Composition of artificial feed

Material	Formula 1	Formula 2	Formula 3
Green beans	240 g	240 g	-
Baby corn	-	-	60 g
Corn sprouts	-	120 g	120 g
Corn flour	240 g	-	-
Yeast	72 g	72 g	72 g
Ascorbic acid	7,3 g	7,3 g	7,3 g
Sorbic acid	2,4 g	2,4 g	2,4 g
Methyl parahydroxybenzoate (Nipagin)	4,4 g	4,4 g	4,4 g
Vitamin solution	10.0 ml	10.0 ml	10.0 ml
Agar	20 g	20 g	20 g
Aquades	1000 ml	1000 ml	1000 ml

Results and Discussion

Each formulated feed contains various chemical compositions that serve as nutrients for *S. frugiperda*. The nutrition in the artificial feed includes ascorbic acid (vitamin C) as an antioxidant and phagostimulant, yeast as a source of protein, and carbohydrates as an energy source. In addition, there are also proteins, plant materials, lipids, sterols, preservatives, sorbic acid, benzoic acid, sodium sulfite, sodium bisulfite, additives, chlorinated chlorine, and antibiotics (Susrama, 2017). These chemical substances are mixed with the natural feed for *S. frugiperda*, which consists of baby corn and corn sprouts. If used as a hardening agent, boil it with distilled water and boiling water. According to Kartini (2015), feed modification is carried out while still considering the nutritional content. The modifications that can be made include using cheaper and more readily available substitute ingredients, increasing the quantity of the ingredients used, or omitting some ingredients from the feed recipe.

The feeding of artificial feed is carried out with 3 different formulas (Figure 1). The composition of the materials in each formula is measured and weighed. The process of making formula 1 begins with boiling green beans and agar with 500 ml of aquades. The boiled result is mixed with other ingredients, namely corn flour, yeast, ascorbic acid, nipagin, and vitamin solution. The ingredients are mixed evenly, and then weighed to determine the wet weight. The dough is placed into the printing machine and then baked twice. The first baking was done at a temperature of 200°C for 20 minutes, and the second baking at a temperature of 150°C for 15 minutes. The results of the baking were weighed again to determine the dry weight. Formula 2 and 3 have the same stages, but differ in the corn preparation. Formula 2 uses corn sprouts, while formula 3 uses baby corn. The corn sprouts and baby corn are first chopped into small pieces and then blended. According to Santoso and Ekastuti (2013), the low quality of leaves can be compensated by adding the necessary nutrients using artificial feed.

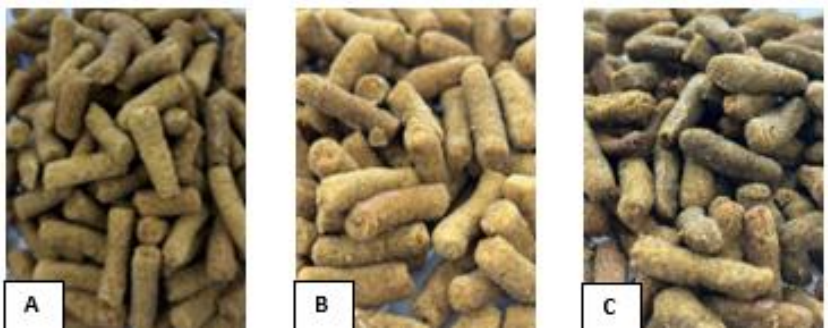

Figure 1. Final results of artificial feed. (a) Formula 1; (b) Formula 2; (c) Formula 3.

The results of feed production with 3 formulas showed a difference in color, so observations were made using several parameters (Table 2). The formulated feed that was prepared was observed using 5 parameters: wet weight, dry weight, weight per 100 grains, color, and the hardness level of the feed against impact (Syamsu et al., 2007). Wet weight and dry weight are measured using a digital scale. The research results show that in formulas one and two, the feed is brownish-green, while formula three is green. The weight per 100 artificial feed pellets shows that formula 1 has the highest weight, while formula 3 has the lowest weight. The highest dry weight and wet weight were obtained from formula 1, while the lowest weight was obtained from formula 3. Formula 3 has significant differences from Formula 1 and 2, particularly in terms of toughness and color. The texture of Artificial feed has varying levels of moisture, ranging from dry to very humid. Feed stored in jars under humid conditions shows mold growth and emits an unpleasant odor. An improper combination of ingredients or mistakes in storage can cause the feed to mold quickly. Modifications in storage also need to be made to prevent feed from molding. According to Carlile and Watkinson (1994), the moisture causes the fungal hyphae to spread across the surface of the substrate.

Table 2. Results of the observation on artificial feed

Type of Feed	Parameter				
	Wet Weight	Dry Weight	Weight 100 Grains	Color	Hardness Level
Formula 1	1.119 gr	640 gr	67 gr	Light brown	Hard
Formula 2	880 gr	460 gr	55 gr	Light brown	Little hard
Formula 3	448 gr	220 gr	41,5 gr	Brownish green	Soft

The composition of the third artificial feed contains pure and processed carbohydrates; the pure carbohydrates come from corn sprouts and baby corn. Corn flour and soybean flour are processed materials from original corn and soybeans. According to Isnawati (2009), carbohydrates are the main source of energy in metabolism, while fats and proteins serve as energy reserves. Carbohydrates, proteins, and fats are digested with the help of hydrolytic enzymes that break down macromolecules into monomers such as glucose, amino acids, and glycerol fatty acids. These monomers are then absorbed by the intestines and enter the circulatory system, where they are taken into cells for further processing to produce energy in the form of ATP (*Adenosine Triphosphate*).

The results of the artificial feed formulation must be tested on *S. frugiperda* first to determine its effectiveness. According to Gunawan (2023), the advantages of artificial feed are that it is practical and can be used at any time, the production process does not take long, and its composition can be modified as desired. The disadvantage of artificial feed is that it is relatively more expensive, so it is necessary to find alternative materials with the same function that are more economical. According to Singh (1977), the success ratio of artificial feed production is influenced by several factors, namely information on nutritional needs, chemical composition, natural food, feeding behavior, and the habitat of the species.

Artificial feed is feed intentionally made by humans to maintain insects, taking into account its nutritional content that supports the growth, development, movement, immunity, and reproduction of insects. Artificial feed is often chosen by researchers because it is easier to produce, always available, and can be modified according to the researchers' needs while considering its nutritional content (Elvira et al., 2010). The composition of chemical and natural ingredients in artificial feed will affect the nutrition of insects. According to Wibisono (1999), artificial diets are produced using both natural and chemical ingredients. Plant materials including seeds, leaves, and fruits can satisfy the natural elements, whereas yeast extract, ascorbic acid, and

other compounds can satisfy the chemical elements. Singh's statement (1982) indicates that the characteristics of artificial insect feed are that it remains durable when stored without reducing its nutritional content, and its production process does not take a long time. Artificial insect feed should be modifiable according to human preferences so that its nutritional content can be determined and microbial and fungal contamination can be minimized.

The artificial feed that has been stored for one month shows signs of fungal contamination. The feed turned into crumbs, had an unpleasant smell, and there was fungal spore growth. This is possible due to the use of sorbic acid preservatives being below normal standards. This statement is supported by the research of Taufika et al., (2022), which found that during the maintenance period, fungal spores grew on the artificial feed. The contamination of artificial feed by mold is likely caused by the use of artificial feed preservatives that are below normal standards. Observation results show that contamination of artificial feed by fungi causes some larvae to refuse to eat and avoid the contaminated feed, leading to reduced body size and death. The statement is also supported by Ambarningrum (2001), who stated that fungi are one of the microorganisms that determine the mortality factor of larvae in the order Lepidoptera.

Conclusion

The conclusion is the characteristics of artificial feed for *S. frugiperda*, including color, weight per 100 grains, dry weight, and wet weight of the feed, are influenced by the formulation of the artificial feed. Formula 3 has significant differences from Formula 1 and 2, particularly in terms of toughness and color. The texture of formula 3 tends to be soft and has cavities on the inside. The artificial feed that has been stored for one month shows signs of fungal contamination. This is possible due to the use of sorbic acid preservatives being below normal standards. The composition of chemical and natural ingredients in artificial feed will affect the nutrition of insects.

Acknowledgment

This research received financial support from the Institute for Research and Community Services of UPN “Veteran” Jawa Timur through the "PDP 2024" scheme. Therefore, we would like to express our gratitude for the financial support for this research.

References

Ambarningrum, T. B. (2001). Tabel hidup ulat grayak (*Spodoptera litura*) (Lepidoptera: Noctuidae) dalam kondisi laboratorium. *Jurnal Sains Teknologi, 7*, 21-28.

CABI. (2019). *Spodoptera frugiperda* (Fall Armyworm). ISC

Carlile, M. J., & Watkinson, S. J. (1994). *The fungi.* Academi Press Harcout Brase & Company Publishers. London.

Elvira, S., Gorría, N., Muñoz, D., Williams, T., & Caballero, P. (2010). A simplified low-cost diet for rearing *Spodoptera exigua* (Lepidoptera: Noctuidae) and its effect on *S. exigua* nucleopolyhedrovirus production. *Journal of Economic Entomology*, *103*(1), 17-24.

Gunawan, A. F. (2023). *Pengaruh pakan alami dan pakan buatan terhadap kebugaran ulat grayak (Spodoptera frugiperda J.E). Smith*. Fakultas Pertanian: Universitas Lampung.

Isnawati. (2009). *Biokimia*. Surabaya: Unesa University Press.

Kartasudjana, R., & Suprijatna, E. (2006). *Manajemen ternak unggas*. Penebar Swadaya Jakarta.

Kartini. (2015). Kacang koro, *Canavalia ensiformis* (Linn) dan kuning telur puyuh, *Couturnix japonica* (Temminck & Schlegel) sebagai pakan buatan *Crocidolomia binotalis* (Zeller) (Lepidoptera: Pyralidae). *Tesis*. Yogyakarta: Fakultas Biologi, Universitas Gadjah Mada.

Lestari, S., Ambarningrum T, B., & Pratiknyo, H. (2013). Tabel hidup *Spodoptera litura* Fabr. dengan pemberian pakan buatan yang berbeda. *Jurnal Sain Veteriner*, *31*(2), 166-179.

Maldonado, J., Pereira, T., & Polonia, J. (2011). Arterial stiffness predicts cardiovascular outcome in a low-to-moderate cardiovascular risk population: the EDIVA (Estudo de DIstensibilidade VAscular) project. *J Vasc Surg*, *54*(3), 911.

Nalim, D. M., & Parra, J. R. P. (1993). *Biologia, nutricao quantitativa e controle de qualidade de populacoes de spodoptera frugiperda (jE simth. 1797) em duas dietas artificiais. Resumos.*

Oomen, P. A. (1982). Studies On Population Dynamics of Scarlet Mite, Brevipalpus phoenicis, A pest of tea in Indonesia. *Meded Landbouwhoge School Wagengingen, 82,* 1-82.

Santoso., & Ekastuti, D. R, (2013). Pertumbuhan ulat sutera *Bombyx mori* (Lepidoptera: Bombycidae) pada berbagai sumber protein dalam pakannya. *Jurnal Ilmu Pertanian Indonesia (JIPI)*, *18*(2), 92-96.

Singh, P. (1977). *Artificial diet for insects, mites, and spiders*. Plenum Data Company, New York. Pp. 201-209.

Singh, P. (1982). *Artificial diet for insect, mites and spiders (2nd ed).* New York: IFI/Plenum.

Sudarjat, Rosmiyati, A., Sunarto, T., & Kurniawan, W. (2020). Pengaruh komposisi pakan buatan terhadap perkembangbiakan *Menochilus sexmaculatus* Fabricius (Coleoptera: Coccinellidae). *Jurnal Agrikultura*, *31*(2), 116-125.

Susrama, I. G. K. (2017). Kebutuhan nutrisi dan substansi dalam pakan buatan serangga. *Agroekoteknologi Tropika*, *6*(3), 310–8.
Syamsu, J. A. (2007). Karakteristik fisik pakan itik bentuk pellet yang diberi bahan perekat berbeda dan lama penyimpanan yang berbeda. *Jurnal Ilmu Ternak Universitas Padjadjaran*, *7*(2), 123.
Taufika, R., Siti, S., & Dian, H. (2022). Pemeliharaan ulat grayak (*Spodoptera litura* Fabricius) (Lepidoptera: Noctuidae) menggunakan pakan buatan pada skala laboratorium. *Agromix*, *13*(2), 47-54.
Wibisono. (1999). Rearing of bollworm on artificial diet. *J. Econ. Entomol., 55,* 140-148.