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Drosophila melanogaster as a Feed Supplement for Swallow *(Collacalia fuchiphaga)*

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Abstract

This study indicates that treatment of *D. melanogaster* as a feed supplement in swallow (*Collacalia fuchiphaga*) where fermented by bran can increase the production of *D. melanogaster* insect and improve the quality of bird's nest including shape, thickness and weight. Swallow breeders can improve the quality and quantity of nest by adding *D. melanogaster* insect as a feed supplement in the buildings which are cultured on fermented bran for minimal costs required and the use of simple technology and can accelerate post-harvest when dry season due to reduced of insects' availability in nature. There was a linear relationship between the amount of feed and weight of the bird on X = 0.01 where $t_{hit} = 26.16 > t_{0.94(43)} = 1.67$ with the regression $\hat{Y} = 1.43\ X + 1.67$. It was the result of feeding (*D. melanogaster*) which has 55.19% proteins, as well as the weight of a real nest. At X = 0.01, $t_{hit} = 6.95 > t_{0.99(38)} = 2.42$ and thickness of the nest was obtained $t_{hit} = 12.26 > t_{0.99(38)} = 2.42$.

Keywords: *Drosophila melanogaster*, swallow (*Collacalia fuchiphaga*), fermented bran.

INTRODUCTION

These days, breeding swallow is currently rife in several cities in Indonesia, especially in low-lying areas, whereas before 1980s, swallow house only found in cities near north coast of Java Island, such as Gresik, Tuban, and Indramayu. But now swallow house easily found on Sumatra Island, Kalimantan and Bali, even Sulawesi which is not a spread area of white nest swallow, now participated in developing.

The explosion of swallow cultivation is occurred after the convening of CITES (Convention of International Trade in Endangered Species of Wild Flora and Fauna) workshop regarding swallow trading in November 1996 in Surabaya. This swallow cultivation is not only in Indonesia but also up in Malaysia and Thailand, and even Philippines. Swallow nest is exported to many countries such as Singapore, Hong Kong, China, Malaysia, and Taiwan.

Swallow comes from the family of *Apopiade*, *Apopiade* family consists of two groups. The first group is the genus of *Chaetura* (spines tail swallow), genus of *Collocalia* (cave swallow) and genus of *Cypseloides* (black swallow from North America). The second group is only one genus namely *Apus* (Anonymous, 2007). According to the data, swallows have a closer relationship with hummingbirds from *Trochiliade* family in America, because they both are a part of *Apodiformes* order.

Cave swallow or *Collacalia* is recorded has 26 species and 12 species, some of them found in Indonesia. However, from its many species, only two species which is popular in business world, namely *Collacalia fuchiphaga* and *Collacalia maxima*. It is because the nest generated from these two species are hunted since many hundreds years ago. While, according to previous literature records, grouping genus and species of swallow is still being debated. Some of the literature published around 1990 mentioned that Indonesia has three species of swallow which its nest was categorized as "*edible-nest swiflets*" able to be eaten, *Collacalia fuchiphaga* or *Aerodramus maximus*, and *Collacalia germane* or *Aerodramus Germani*.

According Chentler and Driesseus (1995), *Collacalia germane* from *Collacalia fuchiphaga* species is not considered as a species but a race of *fuchipahaga* and the spread of *C. germani* is not found in Indonesia, but on the island of Hainan in southern China, the coastal Vietnam, Cambodia coast, the islands of Mergui -Birma, southern Thailand, peninsular Malaysia and the southern Philippines.

Table 1. Distribution Collocalia fuchiphaga and Collacalia maxima

Common Name	**Alias**	**Race**	**Distribution**
Walet Sarang Putih (Edible-nest swift) *Collacalia fueliphaga* (Thunberg 1812)	German-swift Brown-rumped Swift Thunberg's Swiflet *Aerodramus fuchiphagus*	*C.f.fuchiphaga* *C.F.perplexa* *C.f.dammermani* *C.f.micans* *C.f.vestita* *C.f.inexpectata* *C.f.germani*	Jawa, Belitung. Flores. Sumba, Sawu, Timor. Sumatra, Kalimantan. Andaman Islands, Nicobar Hainan Island, South China, Malaysia.
Walet Sarang Hitam (Blacko-nest Swift) *Collacalia maxima* (Hume 1878)	Low's swift Robinson's	*C.m. maxima* *C.m. lowi* *Swift indo* *Malayan swift* *Aerodramus maxima*	Sumatra, Nias Islands West Kalimantan West Java South East Kalimantan

(Source: Swallow Cultivation, R. Agro Media, 2007)

Swallow comes from the family of *Apopiade*, which consists of genus *Chaetura* (spines tail swallow), genus *Collacalia* (cave swallow) and genus *Cypseloides* (black swallow from North America). Cave swallow or *Collacalia* has recorded 26 species and 12 species which are found in Indonesia (Rachman and Typhoon, 2007), in business world, there are only two species *Collacalia fuchipaga* and *C. maxima*, because the popularity of their nest. *C. fuchifagus*'s nest is made entirely from saliva resulting in a clean white swallow nest.

Viewed from the taxonomic of swallow:

Kingdom: Animalia

Phylum: Chordata

Sub Phylum: Vertebrates

Class: Aves

Order: Apodiformes

Familia: Apodidae

Genus: Collacalia

Chaetura

Cypseloides

Species: Collacalia spp

(Source: Eka, 2000)

In Indonesia, there are three species of swallow nest categorized as "edible nest swiftlest" namely, namely *C. fuciphaga*, *C. maxima* and *C. Germani*. Meanwhile, according to Eka (2000), the distribution of *C. fuciphaga* and *C. Germani* was not found in Indonesia. These races was only found on the island of Hainan in southern China, the Coastal Vietnam, Cambodia coast, Margui-Burma Islands, southern Thailand, peninsular Malaysia and the southern Philippines.

Although in the human life insects can have benefits, but not a few insects can cause harm to human life. One of the causes of damage to the crop of fruit is fruit fly *D. melanogaster*. However, by knowing its life cycle, then can be determined steps to control the problem on the decay of fruit crop.

Generally, *D. melanogaster* is found in fruits, vegetables which are and will decay as well as found in landfills around the human life. One of the properties of this insect, its life is cosmopolitan and easily captured, easily bred, small size so that they can be maintained in the laboratory, in addition to its short life cycle.

D. melanogaster has a short life cycle ranges from 10-14 days depending on environmental conditions (temperature) and has a lot amount of population.

MATERIALS AND METHODS

Research has been conducted in the village of Kamangta Minahasa started in March 2015 to April 2016. Breeding *D. melanogaster* with bran and yeast media by using fermentator was made of plastic bottles as many as 45 pieces.

Swallow was hatched in the oven as many as 50 eggs and hatched 43 young swallow and on second day, young birds were fed larvae *D. melaogaster* 3 times a day (morning, noon and afternoon).

Lapse of 45 days, the birds were fed larvae *D. melaogaster* and their weight were weighed, as well as the control young swallow which were not fed *D. melanogaster*. Weighing carried out for 45 days where the birds cannot fly yet.

Further treatment after the birds can fly, then their stomachs were dissected, their stomach contents were analyzed insects which were eaten by the young swallow. For the thickness of bird's nest was measured at harvest spoils 5 months after the birds can fly.

RESULTS AND DISCUSSION

Observation results show that *D. melanogaster*'s egg had white milk transparent color with a size of 0.5 mm elliptical shape with a long antenna (like a horn) in the interior section of larvae in the form of first instar (I) turn into second instar larvae (II) with the enlarged and elongated size looked from the black color of mouthpiece of second instar larvae *D. melanogaster* (II). Larvae had an enlarged part of the body, looks to be more clear, black hidden form, in the interior of larvae and *D. melanogaster* larvae on third instar (III).

After going through the phase of *D. melanogaster* larvae, it looks accumulated on the tube wall (bottle) began to move slowly and finally settles in a place, shows the presence of membranes which surrounding the larvae. At this point in *D. melanogaster*'s life cycle experiences pre-pupa phase. Pre-pupa previously comes from pupae stage earlier, the color of pre-pupa was still in cream transparent color, where the pre-pupa timing was only occurs for approximately 48 hours, then pre-pupa experienced color changes to brown and enter the pupa phase, at this phase *D. melanogaster* was not active but actually in the inside occurred the process of organs formation that will form the imago of a perfect insect *D. melanogaster* with wings, head, thorax, abdomen, legs, eyes ocelli, and composite eyes after the pupa phase.

In observation of *D. melanogaster* that has been drugged with chloroform was observed by using a microscope to look at the entirely shape of *D. melanogaster* body on Pentridis which was inverted with a brush. These observations include a gender where the appearance of male flies's ass has a blunt posterior end, while the female has a pointed posterior end. Another feature of the body is the male has a body size smaller than the female insects.

Observation of the composite eyes of *D. melanogaster* flies show a red eye color, elliptical and there are also ocelli eyes which size smaller than the composite which is at the top, between the two circular composite eyes.
Murmurings were not tapered and forked while the head shape was elliptical and thorax was orange (cream) color covered with a lot feathers with segmented abdomen clearly appearance in black stripes. *D. melanogaster* wings longer than the abdomen, starting from the thorax with transparent color and straight wings shape.

Capability of production is closely related to the availability of nutrients in the medium in fermentation and population growth also influenced by the sex ratio which is cultivated in bran artificial media (rice bran) which is fermented by the different comparison of bran, yeast, water.

The longer the carbon chain of organic compounds produced in fermentation media, the more fragrant artificial feed (aromatic) and growing number of insect *D. melanogaster* which are interested to breed.

Nutrient content of food is the most important for eggs production for female insects in *D. melanogaster*, fructose and sucrose are necessary for eggs production but less important for larvae. When the development of the eggs is slow, it can be concluded that the supply of food from the parent at the egg time does not meet the requirements for the nutritional value of eggs. The quality of food determines the number of eggs laid on most insects.

The results of laboratory analysis of breed *D. melanogaster* show a content of 55.19% protein, 1.80% carbohydrates, 6.75% fat, 3.55 ppm Na, 50.34 ppm K and 288.71 calories. This insect had small size (2 - 4 mm) can be consumed by predator swallows (*Collacalia fuchiphaga*) as feed, from the research results of young swallow fed by the larvae and adults of *D. melanogaster* showed positive correlation were very noticeable regression $\hat{Y} = 1.43 X + 1.67$ while weight test for those which is fed non-treatment and treatment show that the obtained weight from treatment significantly higher for $\alpha = 0.01$, $t_{hit} = 26.16 > t_{0.95(43)} = 1.67$.

The research results of swallow (*Collacalia fuchiphaga*) which had been bred in a house (building) shows that the dry post-harvest season which previously has the timing of making nest 80 days can be reduced to 65 days, due to the availability of food *D. melanogaster* from bran culture results (rice bran) that fermented. *D. melanogaster* potentially reduces the post-harvest period in dry season. Beside that, swallow business not absolutely has to in coast, on the mountain area as well can be developed with the addition of insects feed through fermented bran captivity (rice bran).

The negative impact of the dry season and the reduced populations of insects in the wild affects the swallow life that will impact on reducing saliva for nesting. When the insect population decreases, the distance of swallow prey is farther wanders in hopes of getting insects, lost birds fatigue and did not return to the building resulted in the

declined of swallow. Supplementary feeding in order to anticipate things as mentioned above and supplementary food should be live insects.

Supplementary food *D. melanogaster* will give a positive contribution to the production of nest, in terms of weight and thickness as it has been tested for heavy for $\alpha = 0.01$, $t_{hit} = 6.95 > t_{0.99\,(38)} = 2.42$ and nest's thickness was significantly higher at $\alpha = 0.01$, $t_{hit} = 12.26 > t_{0.99\,(38)} = 2.42$.

The life and development of swallow are very dependent on the environment, therefore in swallow farming, environmental management issues must be considered properly and the quality of nest productivity generated will be very dependent on the environment. The most important of relationship between swallow and environment is the presence of small insects as a food source, with a size of less than 5 mm.

Digestion of food in the swallow takes place in gastrointestinal organ which is composed of various organs that are functionally can be divided into four parts, namely food acceptor area, storage area, digestion area and absorption of nutrients as well as water absorption and excretion area. The reception area is mouth which is equipped by teeth and salivary glands. Saliva contains amylase which works to digest carbohydrates, this organ has a charge to bring food from mouth to stomach by peristalsis movement, the storage area is gizzard and gastric.

Results of the research conducted in Kamangta village, Minahasa showed that treated and non treated swallow in the split gizzard of birds shows:

Table 2. The percentage of incests in the swallow 's gizzard in Kamangta were not given the treatment.

Order	Family	Percentage
Diptera	*Drosophilidae*	45
	Phoridae	
Coleoptera	*Tenebrionidae*	20
Homoptera	*Aleyrodidae*	10
Isopetra	*Kaloptermitidae*	10
Others	-	15*

Table 3. The percentage of insects in the swallow's gizzard in Kamangta were given the treatment.

Order	Family	Percentage
Diptera	*Phoridae*	
	Psychodidae	75
	Drosophilidae	
Coloeptera	*Tenebrionidae*	
	Silvamidae	20
Others		5*

Description: etc; unidentified insects because it was already damaged*

The function of gastric is as a storage of khin (partially digested food). Gastric has functions to digest through excreting protease enzyme (zymogen) and gastric acid. The process of digestion and absorption of nutrients take place in the gut during enzymes digestion process which involve enzymes that breaks carbohydrates, fats, and protein crusher (Terra and Ferreika, 1994). The carbohydrase enzymes break glycosidic bond resulting disaccharide, trisaccharide, and poly saccharides. Based on carbohydrate constituent, saccharide units can be divided into two polysaccharides and oligosaccharides (Martin et al, 1984). Salivary amylase breaks carbohydrates by breaking 1,4 glycosidic on liver and glycogen produceing maltose, glucose and oligosaccharide (Insaini, 2006). Pancreatic amylase will break down starch into starch, maltotriose and maltose.

From the observed result data, feed for swallow given *D. melanogaster* larvae was cheeper after eggs hatch on the second day. In a day, the given diet was three times, namely in the morning at 9.00am, noon 13.00pm and afternoon 18.00pm. Every cheeper consumes *D. melanogaster* larvae fluctuate daily, as an example in the first day we needed 0.48 grams of larvae. Each larva has weight approximately 1.25 mg, so on the first day was required $\frac{0.48\ gr}{1.25\ mg}$ x 1 larvae = 38.4 larvaes (39 larvaes). For one cheeper until it preparation to fly is needed 127.03 grams *D. melanogater* larvae which means:

$$\frac{127.03\ gram}{1.25\ mg} \text{ x 1 larvae} = 1016.24 \text{ larvaes (1016 larvaes).}$$

With 40 pieces of fermentor and an interval of every two days, then the supply of larvae can be overcome. Differences of cheeper were very clear where the nutritional content of the feed which changes significantly compared to cheeper fed by its mother when the child enlargement in the dry season.

Raw foods such as carbohydrates, proteins and fats are digested enzymatically by carbohydrate, protease and lipase enzymes where digestion of these foods will result in nutrients such as sugars, amino acids, glycerols and fatty acids (Widodo, 2002).

Based on observations of the amount feed and cheeper weight over 45 days, obtained correlation coefficient of the amount of feed variable (X) and weight (Y) was r = 0.97 with regression $\hat{Y}$ = 1.43 X + 1.67

n = 45 observations, obtained

$$T_{hit} = \frac{r\sqrt{r-2}}{\sqrt{1-r^2}} = \frac{0.97\sqrt{45-2}}{\sqrt{1-(0.97)^2}} = 26.16$$ (Jerrold, 1996)

For α = 0.01, t_{hit} = 26.16 > $t_{0.95\ (43)}$ = 1.67 means that there was a significant positive correlation between the amount of feed (X) and weight (Y) with regression $\hat{Y}$ = 1.43 X + 1.67. To test the insect *D. melanogaster* had a high protein as swallow feed, null hypothesis is formulated as follows:

H_0:

H_1: bla bla

Reject H_0, if $t_{hit} > t_{tab}$ (Sudjana, 1992)

To test that hypothesis will be compared with the average weight of young swallow which fed *D. melanogaster* (X_1) with the received directly from its parents (X_2) during the experiment.

X_1 = 6.328 with S_1 = 2.2467

X_2 = 4.86 with S_2 = 2.068

$$S^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2} = \frac{44(2.2467)^2+44(2.068)^2}{45+45-2} = 4.66057$$

$$t_{hit} = \frac{X1-X_2}{S\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} = \frac{6.328-4.86}{\sqrt{4.66057(\frac{2}{90})}} = 4.56$$

for α = 0.01, t_{hit} = 4.56 > $t_{0.95\ (43)}$ = 1.67. It means that the average weight of young swallow which fed larvae *D. melanogaster* significantly higher than the weight of young swallow which directly fed by its parents during treatment.

The results of laboratory analyzes performed on cultured insect D. melanogaster show 55.19% protein, 6.75% fat, 1.80% carbohydrates, 3.55 ppm sodium (Na), 50.34 ppm potassium (K) with the calorie score of 288.71 cal/g.

CONCLUSION

Some scientific information about the regeneration of bird population which directly related to the production of nests produced, as well as the environmental support relating to the availability of insects as feed and geographic location will increase the production of bird's nest which will impact on swallow farmers in the mountains.

There was a linear relationship between the amount of feed and bird weight for $\alpha = 0.01$, $t_{hit} = 26.16 > t_{0.94(43)} = 1.67$ with regression $\hat{Y} = 1.43 X + 1.67$. This is because of the impact of *D. melanogaster* insects which has high protein 55.19%.

Feed type (*D. melanogaster* insect) as a swallow feed which has high protein significantly affect the thickness of bird's nest. For $X = 0.01$, $t_{hit} = 12.26 > t_{0.99138} = 2.42$.

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