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Producción y usos de Tenebrio molitor

Production and uses of Tenebrio molitor

Iliana A. Herrera-Soto [a], Sergio Soto-Simental [a], Juan Ocampo-López [a], Maricela Ayala-Martínez [a], Armando Zepeda-Bastida [a]*

Abstract:

The aim of work is to propose the insect *Tenebrio molitor* as a nutritional alternative and report on their production methods, because not only have nutritional characteristics needed for a good diet for its nutritional high, but also have a variety of qualities beneficial to the health of consumers. It is well known that Mexico is a country with nutritional problems, due to lack of knowledge about nutritional deficiencies and options that people have in their diet; so that an alternative to this problem is to expand knowledge and food choices. *Tenebrio molitor* is known as a nutritional option for the large number of proteins containing, which provide a nutritional option, in addition to the health benefits that may be due to the presence of bioactive peptides. Not much is known about the management that these insects must have to avoid pests or infections during their production, in addition to the specific care necessary for rapid and sustainable production.

Keywords:

Insect consumption, nutritional alternative, protein, coleopter

Resumen:

El objetivo del trabajo es proponer el insecto *Tenebrio molitor* como alternativa nutricional e informar sobre los métodos de producción de este, ya que no solo tienen las características nutricionales necesarias para una buena dieta por su alto contenido nutricional, sino que también tienen una variedad de cualidades benéficas para la salud de los consumidores. Es bien sabido que México es un país con problemas nutricionales, debido principalmente a la falta de conocimientos sobre opciones nutricionales y a las deficiencias que las personas tienen en su dieta; por lo que una alternativa a esta problemática es ampliar el conocimiento y opciones alimenticias. El *Tenebrio molitor* es conocido como una opción nutricional por la gran cantidad de proteínas que contiene, lo que proporcionan una opción nutricional, además de los beneficios para la salud que pueden tener gracias a la presencia de péptidos bioactivos. No se sabe mucho sobre el manejo que estos insectos deben tener para evitar plagas o infecciones durante su producción, además de los cuidados específicos necesarios para una producción rápida y sostenible.

Palabras Clave:

Consumo de insectos, alternativas nutricionales, proteína, coleóptero

Introduction

Insects are part of the diet in some regions, they are used as a source of protein. Human consumption of insect is associated with countries located in Asia, Latin America and Africa due to its high consumption reported in these places [6]. In tropical countries, most insects are collected from nature, in an inventory carried out, more than 2000 species of edible insects were recognized worldwide;

a Universidad Autónoma del Estado de Hidalgo, Instituto de Ciencias Agropecuarias. Ave. Universidad s/n. ExHacienda de Aquetzalpa, Tulancingo, Hidalgo. MÉXICO. Iliana A. Herrera-Soto, aleli_herrera@hotmail.com; https://orcid.org/0000-0002-6923-0928 Sergio Soto Simental, sotos@uaeh.edu.mx, https://orcid.org/0000-0002-6923-0926; Juan Ocampo López, jocampo@uaeh.edu.mx, https://orcid.org/0000-0002-9208-7216; Maricela Ayala Martínez, ayalam@uaeh.edu.mx, https://orcid.org/0000-0001-5554-218X;; Armando Zepeda Bastida, azepeda@uaeh.edu.mx, https://orcid.org/0000-0003-0572-5206.

*Autor de Correspondencia, Universidad Autónoma del Estado de Hidalgo, https://orcid.org/0000-0003-0572-5206, Email: azepeda@uaeh.edu.mx.

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however, many edible insects have not yet been identified [11]. Insects can be consumed in their different stages: larva, pupa and adults and are used for human food since prehistory. The percentage of insects consumed in order is: coleoptera (31%), lepidoptera (18%), hymenoptera (14%), orthoptera (13%) and hemiptera (10%) 23. They are able to provide the recommended daily amounts of minerals, among which we can mention Fe, Ca, Cu, Mg, Mn and Zn the amount depends on the form of consumption and the number of insects in the diet [8].
It is difficult to generalize about his nutritional composition, but it is known that most insects provide a lot of energy, protein and amino acids necessary for humans, are rich in monounsaturated fatty acids and polyunsaturated fatty acids, contain vitamins and minerals. They have high concentrations of iron and zinc, higher than those of conventional meat (Table 1) [24].

Table 1.- Nutritional content of different insects.

Insect	Protein (g/100 g)	Fat (g/100 g)	Minerals (g/100 g)	Carbohydrates (g/100 g)	Energy (kcal/100 g)
Beetles	3.7-54	3.7-52	1-3	12-34	126-574
Flies	17.5-67	4.2-31	1.24-8	8.38-23	199-460
Grasshopper	33-65	7-54	1-19	7-19	329-622
Bees	1-81	1.3-62	0-6	5-94	234-593
Butterflies	13.2-69.6	7-77	2-8	3-41	126-762
Crickets	13-77	2.4-25.14	2-27	16-30	117-436

Tenebrio molitor

The coleoptera order is the richest order of insects in species, having around 300,000 already registered, it is also the most variable in size, and there are specimens of 0.25 mm up to 15 cm in length. Many of its species are pests of cultivated plants, fruit trees and forests [14]. The Tenebrionidae family is the richest in species, dispersed in warm and arid areas of the planet; larvae and adults feed on plant debris or derivatives, some species of the genera *Tribolium*, *Gnathocerus*, *Palorus* and *Tenebrio* generally live in the soil and take refuge under stones [4]. *Tenebrio molitor* is an edible insect that measures approximately 2.5 to 3 cm, it is consumed in many countries such as Africa, Asia and Australia, is an insect known as a yellow worm and black weevil, it is considered a secondary pest because it's the feeding of grains and seeds [8].
Tenebrio molitor has characteristics that different it from other insects and make it ideal for production and reproduction, among which we can mention to be resistant to certain types of radiation (Co gamma rays at rates of 30 kiloroentgens) ranging from exposures of 8, 32 and 64 Kr, unlike other insects such as house crickets [16], likewise resists low amounts of oxygen without affecting its life cycle, however if there may be developmental abnormalities or a slower development [15]; shows immunocompetence, referred to the ability of an individual's immune system to resist infections and control pathogens [19], several studies have been carried out on the immunity of *Tenebrio molitor*, in one of them is known to have an adaptive immunity, responds with a long-lasting against antimicrobial activity that provides protection against exposure to pathogens, such as fungi [16].

Taxonomic classification of *Tenebrio molitor*

Animalia Kingdom
Edge: Arthropoda
Class: Insect
Order: Coleoptera
Family: Tenebrionidae
Gender: *Tenebrio*
Species: *molitor L* 7.

Life cycle of *Tenebrio molitor*

The life cycle can be divided into four phases, this begins with the eggs, then passes to the larva, pupa or chrysalis and finally the adult female oviposit to begin the cycle again (Figure 1), females oviposit for the first time at 11.5 days of age [17].

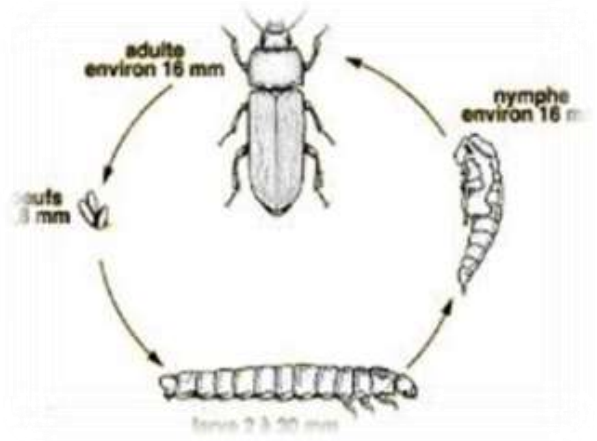

Figure 1.- Life cycle of *Tenebrio molitor.*

The life of the insect is approximately 280 days and this depends on the temperature, quality and accessibility of the food, larvae live for 3 to 4 months, the pupae for 3 to 4 weeks and pass to the adult stage in which they last for 2 to 3 months 1, the nutritional value varies depending on the life stages as shown in Table 2, [21].

Table 2.- Nutritional value of *Tenebrio molitor* stages.

Nutrient	Larvae	Pupae	Adult
	(g/100 g)		
Carbohydrates	5.4	3.69	4.9
Fat	37.2	42.48	46.2
Fiber	6.5	2.4	7.6
Protein	51.64	57.82	63.85
Humidity	62.42 %	64.35 %	63.84 %

Tenebrio molitor diet

The basic requirements known for feeding *Tenebrio molitor* are sources rich in glucose, starch, salt, vitamin B

and water [9], can gnaw the cardboard and wood in the packaging so they are considered a pest [12]; feeding them with wheat bran and lettuce is a viable option [15], the bran must bed is about approximately 3 cm, this should be changed every third days, lettuce should be administered every two days taking care that the bed and the environment is not too wet since this can lead to the growth of undesirable fungi. An option in addition to lettuce is the tomato, but when providing them this must be very careful since it gives them an undesirable smell if left more than 36 hours in the box in addition to being more likely to leave fungi. Entomopathogenic fungi can infect insects through the penetration of their cuticles, through multiple mechanisms of action, which gives them a high capacity to prevent the host from developing resistance. The fungus *Beauveria bassiana* and Vuill (Hypocreales*: cordycipitaceae*), is one of the most studied species in the world, and can infect more than 200 species in nine orders of insects [27], it is for this reason that the substrate and food that is offered to the insect must be observed closely, this prevents fungal contamination.

Tenebrios can be alojated in plastic boxes with the following measures 15cm long, 14cm wide and 9cm high, in each box 100 to 150 tenebrios can be accommodated [15]; they can also be housed in tall plastic containers with bran (Figure 2), or with a different substrate such as corn, soybeans and rice. Symbiotic microorganisms are known to have a significant effect on host metabolism and therefore affect larval growth, may help to increase food digestibility and bioconversion efficiency by stimulating metabolism, these can be found on the substrates offered [14].

Figure 2.- *Tenebrio molitor* on wheat bran bed.

Temperature must be controlled, as it determines the number or number of offspring and also influences the determination of sex. The low temperatures let up their life cycle and also causes some tenebrios to perish during their different stages [2], having a larger quantity of larvae there is an increase in density after 1 month of development; however, female and adult pupae that are raised in isolation are significantly larger than those with densities greater than 20 larvae, normally female pupae are significantly larger than male pupae when raised in isolation [26].

Uses of *Tenebrio molitor*

Tenebrio molitor is considered a pest and for flour companies it is undesirable since it accounts for 50 % of production losses; but in nutrition human and animal, the tenebrio considered an excellent source of protein, the first stage is an egg, it is small and it is not customary to consume it due to its size; the second stage is larva, which is consumed mostly, being one of the most commercialized insects in Europe, it contributes up to 62% protein and is considered a perfect start to entomophagy due to its delicate flavor, they have a light hazelnut flavor and cooked they easily acquire the flavor of complementary foods, they are also sold fried or dehydrated, the crisp texture which is what is ideal for consumption in the form of a snack, they can also be added to smoothies as a source of protein. The third and fourth stages are pupa and adult, these are not normally consumed but they also represent a good source of protein and essential amino acids [21]. *Tenebrio molitor* has been used in diets for broilers as a source of protein evaluating the effect on growth, digestibility of nutrients and carcass and meat traits. Chickens fed this diet obtained a higher feed conversion than those fed a diet with conventional protein source [5]. Its use is mainly made in its larval stage, mainly to serve as food for animal species such as reptiles, birds and fish. *Tenebrio molitor* is one of the species most used for its breeding on insect farms, especially for live food [5], is one of the most widely used insects in insect farms due to its high protein content, which makes it possible to make feed for aquaculture that is rich from a nutritional point of view. Furthermore, it is expected that this species will be one of the most widely used for human consumption or entomophagy [27]. Proteins are responsible for the creation of tissues in living beings. Insects are important from a nutritional point of view because they are rich in proteins, both essential and non-essential (those that the body cannot generate). For this reason, through feeding from insects, we are providing the body with non-essential proteins [26].

Tenebrio molitor has also been used as a protein alternative in a diet to evaluate the performance of sea bream (*Sparus auratasin*). In this study it was shown that replacing fishmeal with *Tenebrio molitor's* flour does not cause any adverse effects in any parameter and gilthead can be marketed [18]. It has been shown that the *Tenebrio molitor* can be used as food for catfish fry, this can sustain the growth of catfish fry giving a survival rate of 70 % [22]. The *Tenebrio molitor* is an excellent source of protein also

used in diets for Rainbow Trout (*Oncorhynchus mykiss*) [10] obtaining encouraging results [13].

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