DOI: 10.26717/BJSTR.2017.01.000228
Abhijit Mitra. Biomed J Sci & Tech Res

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574-1241

Review Article Open Access

Ecosystem Services of Insects

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Received: July 15, 2017; **Published:** July 31, 2017

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Introduction

Insects comprise the most diverse group of multicellular organisms in the planet Earth, which provide several ecosystem services like pollination, pest control (bio-control), decomposition, transference of energy through food chain etc. In addition, insects are widely used today as human edible items and ingredients of fish-feed, turtle-feed, livestock, etc. In this paper we focus on the vital ecosystem services provided by insects with special reference to their services in the domain of human food. Our research stands on the high nutritional value of insects preferably protein which ranges between 13% - 77%. Our paper has two-fold goals namely documentation of selective ecosystem services of insects and highlighting the edible value of insects. In this paper we have intentionally excluded the value of commercially produced insect-derived products like honey, wax, silk, shellac, etc. rather our main focus is to highlight the nutritional value of insects which is the most demanding subject to feed the rapidly rising population in the present world.

Pollination

Insects play an important role in the reproduction of plant species. About one lakh pollinator species have been identified out of which 98% are insects [1]. Over 90% of two lakh fifty thousand flowering plant species depend on pollinators. This is applicable for 75% of the hundred crop species that generate most of the worlds' food grain.

Decomposition/ Biodegradation

The process of waste biodegradation is regulated and controlled by the insect community. Beetle larvae, flies, ants and termites clean up dead plant matter and break them into finer particles for further decomposition by microbial community. Dung beetles (about 4000 species documented) also play a significant role in decomposing manure. If the dung remains on the soil surface about 80% of the nitrogen (N2) is lost to the atmosphere which is one of the prime causes of global warming.

Biological Control of Pest

Pest control is a vital aspect in the domain of agriculture and in most of the cases it is done by using chemicals. This not only harms the environment, but also decreases the productivity of the soil. Today there is an inclination of biological control of harmful insects. The number of insects that feed or prey on other insects is vast. 10% of all insects are parasitoids [2]. Entire orders of insects - such as Odonata (dragon flies) and Neuroptera (net-winged insects such as lacewings and ant lions) - are predators. A large percentage of true bugs (Hemiptera), beetle (Coleoptera), flies (Diptera) and wasps, bees and ants (Hymenoptera) are also predators. The number of beneficial insect species in the average agro-ecosystem typically far outweighs the number of harmful insect species.

Edible Value of Insects

Table 1: Comparison of average protein content among insects, reptiles, fish and mammals.

Animal group	Species and common name	Edible product	Protein content (g/100 g fresh weight)
Insects (raw)	Locusts and grasshopppers: *Locusta migratoria, Acridium melanorhodon, Ruspolia differens*	larva	14-18
	Locusts and grasshoppers: *Locusta migratoria, Acridium melanorhodon, Ruspolia differens*	Adult	13-28

	Sphenarium purpurascens (chapulines - Mexico)	Adult	35-48
	Silkworm (*Bombyx mori*)	Caterpillar	10-17
	Palmworm beetles: *Rhynchophorus palmarum, R. phoenicis, Callipogon barbatus*	Larva	7-36
	Yellow mealworm (*Tenebrio molitor*)	Larva	14-25
	Crickets	Adult	8-25
	Termites	Adult	13-28
Cattle		Beef (raw)	19-26
Reptiles (cooked)	Turtles: *Chelodina rugosa, Chelonia depressa*	Flesh	25-27
		Intestine	18
		Liver	11
		Heart	17-23
		Liver	12-27
Fish (raw)	Finfish	Tilapia	16-19
		Mackerel	16-28
		Catfish	17-28
	Crustaceans	Lobster	17-19
		Prawn (Malaysia)	16-19
		Shrimp	13-27
	Molluscs	Cuttlefish, squid	15-18

Table 2: Examples of energy content of differently processed insect species, by region.

Location	Common name	Scientific name	Energy content (kcal/100 g fresh weight)
Australia	Australian plague locust, raw	*Chortoicetes terminifera*	499
Australia	Green (weaver) ant, raw	*Oecophylla smaragdina*	1 272
Canada, Quebec	Red-legged grasshopper, whole, raw	*Melanoplus femurrubrum*	160
United States, Illinois	Yellow mealworm, larva, raw	*Tenebrio molitor*	206
United States, Illinois	Yellow mealworm, adult, raw	*Tenebrio molitor*	138
Ivory Coast	Termite, adult, de-winged, dried, flour	*Macrotermes subhyalinus*	535
Mexico, Veracruz	State Leaf-cutter ant, adult, raw	*Atta mexicana*	404
Mexico, Hidalgo State	Honey ant, adult, raw	*Myrmecocystus melliger*	116
Thailand	Field cricket, raw	*Gryllus bimaculatus*	120
Thailand	Giant water bug, raw	*Lethocerus indicus*	165
Thailand	Rice grasshopper, raw	*Oxya japonica*	149
Thailand	Grasshopper, raw	*Cyrtacanthacris tatarica*	89
Thailand	Domesticated silkworm, pupa, raw	*Bombyx mori*	94
The Netherlands	Migratory locust, adult, raw	*Locusta migratoria*	179

The world population as of now is 7, 518,254,096 as per the record of 02:35 pm Indian Standard Time (IST) of 14th July, 2017. It is expected that 2050, the projected world population is 9.8 billion and 11.2 billion during 2100 [3]. This enormous population needs food supply on regular basis for their survival and growth. The land and aquatic resources have already reached the critical level and under this circumstance insects can provide an alternative food source as they are rich in protein and other minerals (Table 1). In addition, insects also provide dietary energy (Table 2).

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