



## CONCEALED FACETS OF HONEY BEE STING

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### ABSTRACT

Honey bees are one of the most familiar insects in the world. Incidences of Honey bee stings are very common and symptoms may include minor to major reactions. Apiculturists are easily victimized by bee stings. Wasps, bees and hornets secrete a poisonous fluid which in toxic amounts is hemolytic and neurotropic. Apitoxin or honey bee venom, is a bitter colorless liquid, the active portion of which is a complex mixture of proteins that causes local inflammation and acts as an anticoagulant. Though it doesn't seem alarming but for prevention and treatment of these bee stings, detailed information should be readily available to understand such incidences. Keeping this thing in view, complete description of honey bee sting, including its structure and composition as well as honey bee venom covering its lethal dose, physical characteristics, uses, composition, method of collection, different forms, toxicological effects of various components, signs and symptoms of bee sting along with its management. Ayurvedic perspective of Makshika and symptoms of their bites has also been sorted out from various classical texts.

**KEYWORDS:** Honey bee sting, Apitoxin, Makshika, Bee venom, Makshika damsha.

### INTRODUCTION

Insect bites and stings occur when an insect is agitated and seeks to defend itself through its natural defense mechanisms. Various types of insects come in contact with us in day to day life, insect bite is very common and usually it is ignored. Most of the bites are less harmful and negligible but sometimes poisonous bites could lead to various complications i.e anaphylactic shock. There are millions of insects, however Honey bee is among few insects which are very important for human beings and became a part of their culture. Despite the evidence of an enduring reverence for the Honey bee, human beings have an uneasy relationship with it. Honey bees are absolutely essential for the production of agricultural crops as they pollinate 1/3<sup>rd</sup> of what we eat. Being an Agricultural country, most of the population in India is living in villages and remote areas where less medical services are available. Incidences of insect bites are very common in such areas.<sup>[1]</sup>

Now a days, Apiculture (domestication & culturing of honey bee for Honey and other products like wax) is developing in rural areas through many schemes conducted by KVIC (Khadi and Village Industries Commission), Government of India for employment in the Rural India. Surveys on apiculture industry have shown that death due to bee stings per year in India is 0.007%.<sup>[2]</sup>

#### Honey bee sting

**The structure of the honey bee sting:** The abdomen of Honey bee has 10 segments, seven of which are obvious. The first one is called the propodeum and is attached to the thoracic segments and is better described as a part of the thorax, the remaining part is known as the gaster and outwardly appears to have six segments, the last of this A7. The remaining three segments are internal inside. In some other members of the hymenoptera A8 and A9 becomes an ovipositor, some of these ovipositors drill

into wood in a similar fashion to that which the Honey bees sting penetrates skin.

### The Parts of The Sting

**The cavity within A7:** It is called the sting chamber and the whole of the sting apparatus is enclosed within it when not in use. The apparatus consists of three pairs of plates; oblong, quadrate and triangular. Two pairs of protractor and retractor muscles move the quadrate plates up and down which causes the triangular plate to act as a rocker, converting linear motion of the quadrate plate into a curved motion in the ramus (a flexible extension of the lancet). Thus the two lancets are advanced in an alternating fashion, which gives rise to a vibration that can be felt by the person being stung.

**Action of sting:** When the sting is deployed, the bee bends its abdomen downwards due to the action of the muscles that connect the abdominal plates. The muscles set on the ventral side contracts thereby increasing the overlap between the sternite plates. On the dorsal side another set of muscle contract so that the membrane between the tergite plates is distended. This results in a bent abdomen, which is the combination of the angular ventral movement of the sting shaft. This ensures that the sting shaft enters regularly perpendicularly into the skin of the victim. Perpendicular penetration is the most efficient as venom is delivered more deeply and the path through the tough skin is shortest.

**The shaft of the sting:** It consists of three hollow sharply pointed structures which mesh together rather like the closure of the zip-lock plastic bag to surround a central canal. These are the left and right lancets which are based and the central dorsal stylet. The stylet of its inner end becomes larger and softer, this structure is known as the bulb, is the reservoir for the venom. It has a pair of umbrella valves to push venom down into the shaft as it is forced into the victim. The venom sac and glands that produce other secretions are connected to the bulb.<sup>[3]</sup>

**Ayurvedic Review of Makshika:** Acharya Sushruta described Makshikas in Kalpa Sthan chapter 8 i.e Keetakalpam adhaya whereby he has mentioned 6 types of Makshikas: *Kantarika, Krishna, Pingala, Madhulika, Kashayee, Sthalika*.

**Symptoms of their bites:** At the site of bite person feels itching (Kandu), swelling (Shopha), burning sensation (Daha) and pain (Ruja). Apart from these general symptoms, Acharya Sushruta specifically mentioned symptoms of Kashayee and Sthalika as grayish black Pustules or furuncles and fever like upadravas (shyaav pidika utpatti).<sup>[4]</sup>

Out of these 6 types, Sthalika and Kashayee are Asadhya.

Acharya Charak and Acharya Vagbhata mentioned

Sthagika instead of Sthalika and termed it as praanhar.<sup>[5,6]</sup>

**Symptoms of Makshika Damsha given by Acharya Charak-** Grayish black Pustules or furuncle (shyaav pidika) appears and there is immediate secretion (sadhya prasarvini) from the site of Makshika Damsha just after the sting, burning sensation (daha), fainting (murcha) and fever (jwara) like symptoms also follows.<sup>[5]</sup>

**Apitoxin (Bee Venom)-** Apitoxin or Honey bee venom is a bitter colorless liquid. The active portion of the venom is a complex mixture of proteins, which causes local inflammation and acts as an anticoagulant. It is the rich source of enzymes, peptide and biogenic amines. Apitoxin is produced in the abdomen of worker bee from a mixture of acidic and basic secretion. It is acidic in nature (Ph 4.5 to 5.5). A Honey bee can inject 0.1 mg of venom via its stinger.

Production of bee venom takes place by 2 glands associated with the sting apparatus of the worker bees. Its production increases during the first two weeks of the adult life and reaches a maximum when the worker bee becomes involved in hive defense and foraging. It diminishes as the bee gets older. The Queen bee's production of venom is highest on emergence, probably because it must be prepared for immediate battle with other Queens. When a bee stings it does not normally inject all of the venom held in full venom sac. Only when it stings the animal with skin as tough as ours it loses its sting.

**Dose-**The median lethal dose LD50 of an adult human is 2.8 mg of venom per kg of body weight.<sup>[2]</sup>

**Physical characteristics of venom:** Honeybee venom is a clear, odorless, watery liquid. When coming into contact with mucous membranes or eyes, it causes considerable burning and irritation. Dried venom takes on a light yellow color and some commercial preparations are brown, thought to be due to oxidation of some of the venom proteins. Venom contains a number of very volatile compounds which are easily lost during collection.

**The composition of Honey bee Venom:** A large number of studies have been carried out on the composition of honeybee venom. Much of the basic identification of compounds, their isolation and the study of their pharmacological effects was done in the 1950's and 1960's. There are some comprehensive summaries in Piek (1986) which cover the morphology of the venom apparatus, the collection of venom, the pharmacological effects of bee venom and allergies to the Hymenoptera venom of bees, wasps and ants. 88% of venom is water.<sup>[7]</sup> The glucose, fructose and phospholipid contents of venom are similar to those in bee's blood (Crane, 1990). At least 18 pharmacologically active components have been described, including various enzymes,

peptides and amines. The major components as summarized from Dotimas and Hider (1987) and Shipolini (1984) of Honey bee venom are given below in table. No further discussion of the detailed chemistry and various effects of individual components will be attempted here. Schmidt (1992) presents a comprehensive account of allergies to honeybee and other Hymenoptera venoms. Crane (1990), Dotimas and

Hider (1987) and Banks and Shipolini (1986) give a very good overview of its composition, effects, harvesting and use.<sup>[8]</sup> Venom from other Apis species is similar, but even the venoms from the various races within each species are slightly different from each other. The toxicity of Apis Cerana venom has been reported to be twice as high as that of Apis Mellifera (Benton and Morse, 1968).<sup>[9]</sup>

**Table 1: Composition of Venom from Honeybee Worker.**<sup>[8]</sup>

Class of molecules	Component	% of dry venom <sup>a</sup>	% of dry venom <sup>b</sup>
Enzymes	Phospholipase A <sub>2</sub>		10-12
	Hyaluronidase		1.5-2.0
	Acid Phosphomonoesterase	10-12	1.0
	Lysophospholipase	1-3	1.0
	Glucosidase		0.6
Other proteins and peptides	Melittin	50	40-50
	Pamine	1-3	3
	Mast Cell Degranulating Peptide (MCD)	1-2	2
	Secapin	0.5-2.0	0.5
	Procaine Adolapin	1-2	1.4
	Protease inhibitor		1.0
	Tertiapin <sup>c</sup>	0.1	0.8
	Small peptides (with less than 5 amino acids)	13-15	0.1
Physiologically active amines	Histamine	0.5-2.0	0.5-1.6
	Dopamine	0.2-1.0	0.13-1.0
	Noradrenaline	0.1-0.5	0.1-0.7
Amino Acids	Aminobutyric acid	0.5	0.4
	Amino acids	1	
Sugars	Glucose & fructose	2	-
Phospholipids		5	-
Volatile compounds		4-8	-

#### Uses of Bee venom<sup>[10]</sup>

- Chronic injuries such as bursitis and tendonitis.
- Rheumatoid Arthritis.
- Cardiopulmonary conditions such as hypertension.
- Pulmonary conditions such as Asthma.
- Removal of scar tissues.
- Skin conditions like eczema.
- Hearing loss.
- Bone healing.
- Beauty Products-it reduces the UV damage caused on the skin due to the harmful rays of the sun.
- HIV: Scientists from Washington university school of medicine reported in March, 2013 that nano particles containing bee venom toxin melittin can destroy the human immunodeficiency virus (HIV) while at the same leaving the surrounding cells unharmed.

**Method of Collection of bee venom:** Early methods were surgical removal of venom gland or squeezing the bee to collect the venom from the tip of the sting. Now venom extraction is done by electroshock method and stinging of the adult bee directly to the patient.

**Different forms of bee venom:** Bee venom is marketed in following forms

1. Whole bee's extract.
2. Pure liquid venom and Injectable solutions.
3. Dry crystalline form.

**Storage:** Bee venom should be stored in freezer and always be kept in dark bottles; it can be refrigerated but not more than few weeks.

**Table 2: Toxicological effects of various components of bee venom.**<sup>[2]</sup>

Component	% Venom	Chemical nature	Activity/Pharmacology
Melittin	30-50%	Small, highly basic, 26 amino acid polypeptide of 2840 mole.wt	Pain, cardiotoxin, haemolysin, membrane activity release histamine, depress B.P.
Phospholipase	10-20	Basic stable protein of 15800 roote.wt	Membrane and phospholipid disruptant toxic, pain, cellulysis, Lungs are target

Apamin	3	Highly basic 18 amino acids polypeptide	Neurotoxic causes tremers.
Hyaluronidase	2	Protein of 35000 mol. Wt	Promotes, spreading of other components, no other activities, hydrolysis connectivity tissue.
Mast cell degranulating peptide	2	Highly basic 22 amino acid polypeptide.	Releases histamine etc. from mast cells, pain , anti inflammatory
Histamine	<1	Small unstable biogenic amino of 3 mole. Wt.	Burning, itching, redness immediate local skin pain

**Table 3: Biochemical composition of Honey bee venom of Insects that frequently bites humans.**<sup>[11]</sup>

Enzymes	Composition
Phospholipase	10
A2	12
A1	0
B	1%
Hyaluronidase Acid	1-2%
Phosphates	+
Alkaline Phosphate	+
Lipase	0
Esterase	+
Protease	0
<b>Peptides</b>	
Melittin	40-50%
Apamin	3%
MCD Peptide	2%
Secamin	5%
Tertiapin	1%
<b>Small molecules</b>	
Histamine	0.7 – 1.6%
Dopamine	0.1 – 1.0%
Noradrenaline	1-2%
Leukotrienes	0.003%

**Signs and Symptoms of Honey bee sting:** When bees sting a person, they inject venom through their stinger into the skin of the victim. The honeybee has a barbed stinger that remains in the victim's skin with its venom sack attached. About 3% of people stung by bees have allergic reactions to the sting and up to 0.8% of bee sting victims experience the severe and life threatening allergic reactions known as anaphylaxis.

Most people will have only a localized reaction to a bee sting. In normal reaction to a bee sting, the skin is red, painful, swelling and itching present. The pain usually disappears over a few hours. In systemic allergic reactions, the entire body is affected. The victim may develop rashes, redness, swelling at the site on the body distant from the site of the sting. Symptoms include vomiting, nausea, diarrhea, dizziness. In anaphylactic reaction, victim experience wheezing, difficulty in breathing and a drop in blood pressure that leads to shock if not treated promptly. This type of reaction usually occurs within minutes of the bee sting.<sup>[12]</sup>

**Management and Treatment:** When a bee stings, it barbed stinger into the skin.

1. The first step in management is to remove the stinger as soon as possible as it takes few seconds to 2 minutes for all of the venom to enter in the body. Scrap the stinger with finger nail or edge of credit card. Do not squeeze the attached venom sac as it can release more venom.
2. Wash the area with soap and water.
3. For relieving pain and swelling apply cold compression.
4. Application of antibiotic cream or calamine lotion on the sting site.
5. Oral antihistamine that contains diphenhydramine or chlorpheniramine should be taken.
6. In Anaphylactic shock- Epinephrine (Adrenaline) is given to reduce allergic response of the body, oxygen is given in breathing difficulties, intravenous antihistamines and cortisone to reduce inflammation of air passages. A beta agonist is given to relieve breathing symptoms.<sup>[13]</sup>

## DISCUSSION

There are million of insects, however Honey bee is among few insects which are very important for human beings and became a part of their culture. India is supposed to be not only the cradle of humanity but also the birth place of bee. God Krishna was symbolized by a bee and was called Madhava; born in honey. Hindu drink madhuparka, a mixture of honey and curd during religious ceremonies In Ayurveda Madhu is described as best *Anupaan*. It can be used in both *Stholya* as well as *karshya*. The manifestation of Makshika damsha varies widely from pain to physiological disturbances and even upto death. At the site of bite patient feels itching (kandu), swelling (shopha), burning sensation (daha) and pain (ruja). Apart from these symptoms Acharya Sushruta has specifically described symptoms of Kashayee and Sthalika as grayish black postules (shyaav pidika) and fever (jwara) like upadrvas.

## CONCLUSION

Honey bee sting is very common in our surroundings. The major reaction comes very soon and the treatment cannot always be made available immediately. Usually sting removal is done and mild steroid ointment is applied on the sting site.

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