

April 27, 2023  
**HONEY: A SWEET SOLUTION?**

**Dr. Andrea K. Hubbard**  
Associate Professor; Emeritus  
UConn School of Pharmacy, Storrs, CT  
5000 ft in the Utah desert (Kanab, UT)

1

1

**Disclosure slide statement:**

Dr. Hubbard has no actual or potential conflict of interest associated with this presentation.



<https://www.thesourceotways.com/about-us/apitherapy>

2

2

## Objectives

1. Describe medicinal history of honey
2. List composition and properties of honey
3. Identify diseases and conditions treated with honey
4. Recognize biologic activities of honey

3

3

## Outline

Apitherapy: alternative therapy that uses products that come directly from honeybees

### Facts About the Bee and Honey

#### Medicinal History

- Egypt
- Greece
- Roman
- Christian
- Islam
- Aryuveda

#### Composition

#### Properties

#### OTC Products

### Conditions Treated

- Wound healing
- Anti-microbial
- GI diseases
- CVD
- Diabetes
- Asthma
- Cancer

### Adverse Effects

- Infantile Botulism

### Biologic Properties

- Anti Microbial
- Anti oxidant
- Anti inflammatory
- Apoptosis
- Prebiotic

### Other Bee Products

- Pollen
- Bees wax
- Propolis
- Royal Jelly

### Summary and Conclusions

4

4

## Some Facts About....

The honeybee - highly socialized insect  
*Apis mellifera* L.

### Worker bees

female

- Developed from a fertilized egg
- Cleaning cells, feeding young larva, building wax comb, etc.
- Gathers pollen and nectar
- Defends the hive and has a stinger
- May number as many as 60,000 in a colony
- The worker bee lives for a short period of time



5

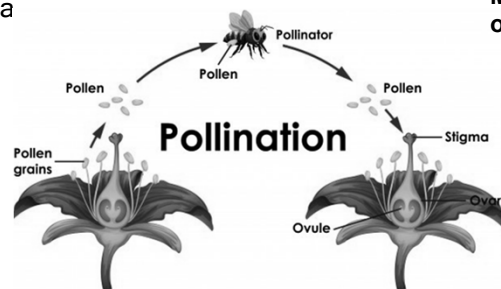
5

### Pollen and Nectar

- Nectar from flowers; sweet liquid that entices the bees to the flower
- Suck up the nectar with their straw-like mouth
- Collect it in a little sac called a **crop**
- The nectar is for energy and becomes honey
- Collect pollen on their legs
- Leave a little bit of that pollen on each new flower
- Pollen needed for larva



**Most bees collect just pollen or just nectar on any trip**



<https://www.thesourceofways.com/about-us/apitherapy>

6

6

## Some Facts About... The queen bee

- Develops from a fertilized egg
- Must mate with a drone to produce fertilized eggs
- Role in the hive is to produce eggs and to release pheromone signals within the hive
- May live for 5 years or more
- **Royal jelly**, a white, viscous jelly-like substance
- Solely consumed by the queen bee
- Fed to queen bee throughout her entire life
- Consists of water (50%-60%), proteins (18%), carbohydrates (15%), lipids (3%-6%), mineral salts (1.5%), and vitamins



7

7

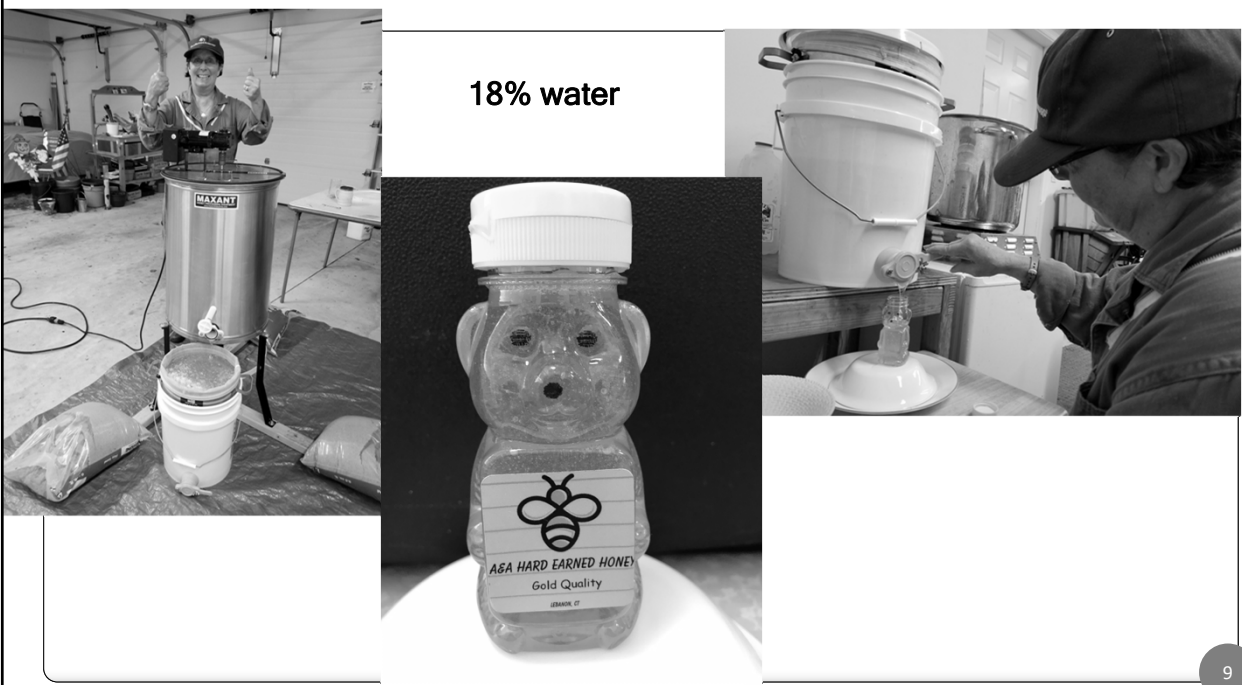
## Honey in CT



8

8

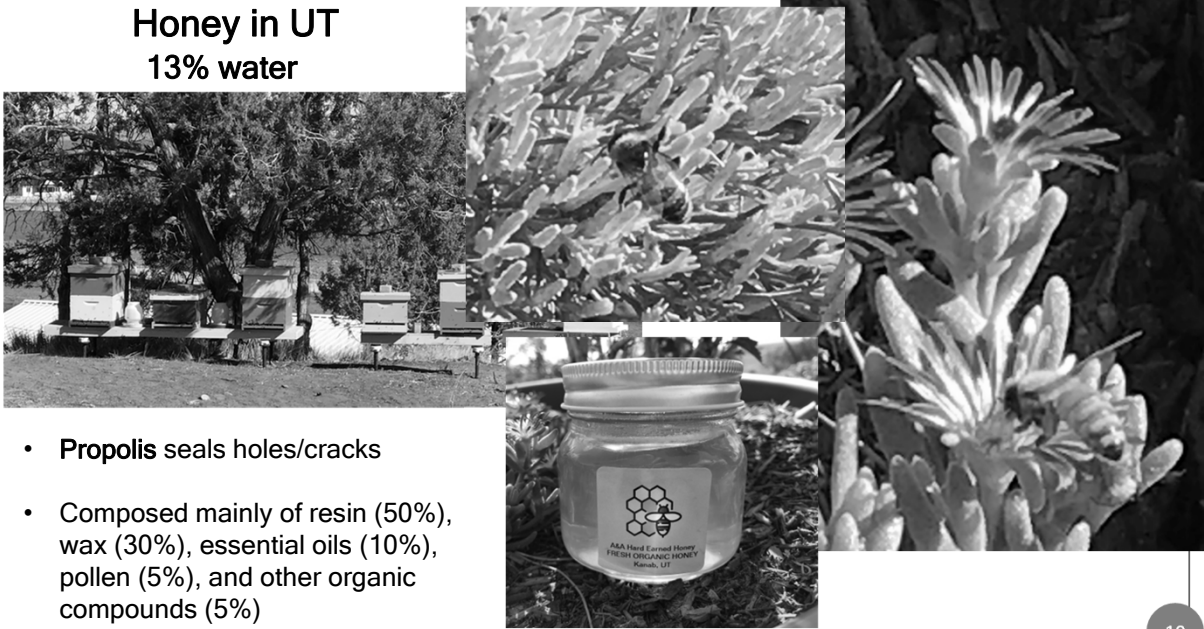
18% water



9

9

Honey in UT  
13% water



- **Propolis** seals holes/cracks
- Composed mainly of resin (50%), wax (30%), essential oils (10%), pollen (5%), and other organic compounds (5%)

10

10

## Single most important pollinator

### Honey Bee

- Nut crops
- Fruit trees
- Berries
- Row crops
- Depend 80% to 100% on honeybee pollination.

Insects 2019, 10, 356

11

11



Breakfast with bees



Produce with bees



Breakfast without bees



Produce without bees

<https://surry.ces.ncsu.edu/2020/06/pollinator-week-june-22-28-2020/?src=rss>

12

12

### Multiple Choice Question #1

Which of the following is a correct statement? :

- a. Honeybees have minimal importance in the propagation of crops.
- a. Propolis helps in the maturation of the queen bee.
- b. Royal jelly helps in the development of the king bee.
- c. Honeybees collect nectar and pollen in separate flights.

13

13

### Medicinal History of Honey

Ancient Egyptians, Assyrians, Chinese, Greeks and Romans: honey for wounds and intestinal diseases

#### Ancient Egypt

- In 900 remedies; mixed with wine and milk
- Offered honey to their deities as a sacrifice
- Used honey for embalming the dead
- Antibacterial properties that helped heal infected wounds

#### Ancient Greece

- Honey and vinegar. Used for gout and certain nervous disorders
- Hippocrates prescribed this combination for pain, water and honey for thirst, and a mixture of honey, water and various medicinal substances for acute fevers

#### • Roman Empire

- Gift to the gods; widely used in cooking

#### • Christianity

- Production of honey and beeswax increased to meet demand for candles for the church

#### • Islamic Medicine

- Mohammad treatment of diarrhea, treatment of tuberculosis

#### • Ayurveda - digestion, cough, teeth and gums, insomnia, skin, cardiac

14

14

Mesolithic cave paintings from Spain from 7000 B.C. shows the first records of beekeeping, but bee honey fossils date back about 150 million years!



<https://www.petibuchel.com/the-uses-of-honey-and-wax-in-ancient-egypt/>

- Beeswax was used for
- plugging mummies' orifices
  - glue
  - hair styling
  - model making and painting

The picture is of the hair and hair extensions on the head of the mummy of Nefertari



<https://www.apicultural.co.uk/tears-of-re-beekeeping-in-ancient-egypt>

15

15



26th Dynasty hieroglyph depicting a beekeeper with their hives of bees

<https://www.loe.org/shows/segments.html?programID=15-P13-00046&segmentID=7>



16

16



An ancient Greek amphora depicting four men being stung by bees after attempting to steal honey from the hives that nourished the infant Zeus.



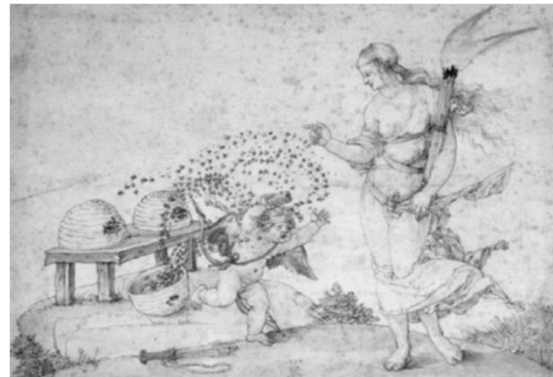
<https://www.planetbee.org/planet-bee-blog/the-sacred-bee-ancient-greece-and-rome>

17

17

Because bees were considered to have special powers, they were often used as **emblems**:

- In the third century BC, used on coins in the Greek city of Ephesus
- Emblem of Eros / Cupid, god of love and sexual desire



Cupid the Honey Thief by Albrecht Durer, 1514

<https://meli-feli.com/en/the-history-of-honey/>

<https://www.planetbee.org/planet-bee-blog/the-sacred-bee-ancient-greece-and-rome>

18

18

### Multiple Choice Question #2

**Honey or products of bees have been used in the following ways for centuries:**

- a. Treatment of infected wounds
- b. Element in marriage ritual
- c. Food for livestock
- d. Treatment for loss of hair

19

19

### Honey's Eternal Shelf Life, Explained

That honey found stored in an ancient Egyptian tomb? Yeah, it's still good to eat.

Honey stands out for one remarkable reason:

- It never spoils
- No need to refrigerate
- Store unopened at room temperature
- May come out of solution to crystallize



Honey is hygroscopic, draws and holds water out of the air

- Trophallaxis
- Enzymes in crop
- Stored honeycomb, evaporation occurs (high temperature & fanning of wings)
- Once water content is 18% or lower, capped with beeswax
- Use honey in winter to stay alive

20

20

## Outline

### Facts About the Bee and Honey

#### Medicinal History

- Egypt
- Greece
- Roman
- Christian
- Islam
- Aryurveda

#### Composition

#### Properties

#### OTC Products

### Conditions Treated

- Wound healing
- Anti-microbial
- GI diseases
- CVD
- Diabetes
- Asthma
- Cancer

### Adverse Effects

- Infantile Botulism

### Biologic Properties

- Anti Microbial
- Anti oxidant
- Anti inflammatory
- Apoptosis
- Prebiotic

### Other Bee Products

- Pollen
- Bees wax
- Propolis
- Royal Jelly

### Summary and Conclusions

21

21

## Composition of Honey

180 different compounds

- Composed of sugars (about 80%)
- Water (approximately 17%)
- Other constituents (approximately 3%)
  - Enzymes: glucose oxidase (oxidation of glucose)
  - Oxidants: H<sub>2</sub>O<sub>2</sub>; MGO
  - Gluconic acid (mild organic acid)
    - pH: 3.9
    - acidity and taste
    - antioxidant activity
  - Formic acid (strong organic acid)
  - Amino acids: Proline
  - Vitamins: B complex (pollen); vitamin C
  - Minerals: potassium
  - Phytochemicals: pigments; clear to dark amber; suspended pollen
  - Flavonoids; phenolic acids
    - Taste/color in honey: floral origin; geographical area, climate, species of bee
    - within 2 miles of hive

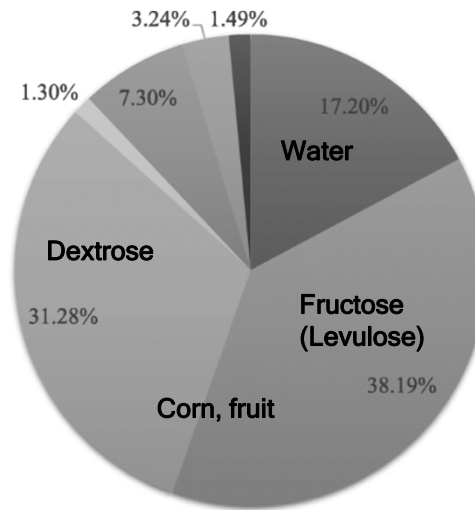
<https://foodstruct.com/food/honey>

22

22

### Nectar broken down to fructose and glucose

Many of these sugars are formed during the honey ripening and maturation time



Ranneh et al. BMC Complementary Medicine and Therapies (2021) 21:30

■ water 17.20% ■ Levulose 38.19% ■ Dextrose 31.28% ■ Sucrose 1.30%  
 ■ Maltose 7.30% ■ Others 3.24% ■ High sugars 1.49%

23

23

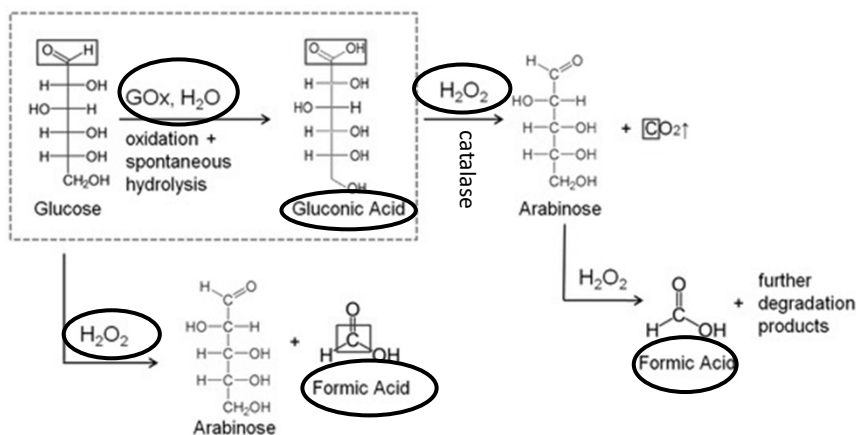
### Composition of Honey 180 different compounds

- Composed of sugars (about 80%)
- Water (approximately 17%)
- Other constituents (approximately 3%)
  - Enzymes: glucose oxidase (oxidation of glucose)
  - Oxidants: H<sub>2</sub>O<sub>2</sub>; MGO
  - Gluconic acid (mild organic acid)
    - pH: 3.9
    - acidity and taste
    - antioxidant activity
  - Formic acid (strong organic acid)
  - Amino acids: Proline
  - Vitamins: B complex (pollen); vitamin C
  - Minerals: potassium
  - Phytochemicals: pigments; clear to dark amber; suspended pollen
  - Flavonoids; phenolic acids
    - Taste/color in honey: floral origin; geographical area, climate, species of bee
    - within 2 miles of hive

24

24

### Glucose oxidation to gluconic acid and other by-products



*Catalysts* **2020**, 10(3), 269

25

25

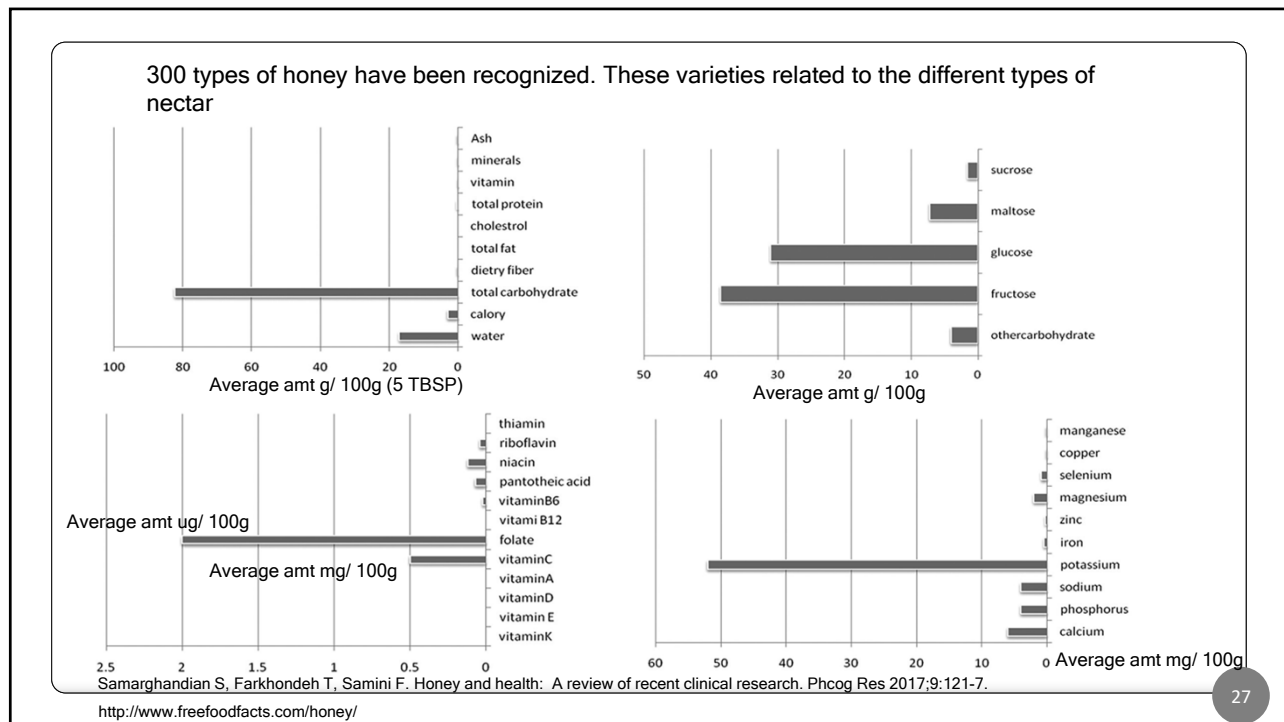
### Composition of Honey

180 different compounds

- Composed of sugars (about 80%)
- Water (approximately 17%)
- Other constituents (approximately 3%)
  - Enzymes: glucose oxidase (oxidation of glucose)
  - Oxidants: H<sub>2</sub>O<sub>2</sub>; MGO
  - Gluconic acid (mild organic acid)
    - pH: 3.9
    - acidity and taste
    - antioxidant activity
  - Formic acid (strong organic acid)
  - Amino acids: Proline
  - Vitamins: B complex (pollen); vitamin C
  - Minerals: potassium
  - Phytochemicals: pigments; clear to dark amber; suspended pollen
  - Flavonoids; phenolic acids
    - Taste/color in honey: floral origin; geographical area, climate, species of bee
    - within 2 miles of hive

26

26



27

## Methylglyoxal (MGO)

- Generated during glucose and fructose metabolism in the crop of bee\*

**Antibacterial properties :**

- H<sub>2</sub>O<sub>2</sub> – oxygen and water due to catalase
- MGO - non-peroxide activity
- Low pH
- Phenolic acids

**Mānuka honey**

- dark, rich and creamy
- Is darker in color, richer flavor profile and a thicker texture.
- Unique antioxidants, prebiotics and an antibacterial

**REGULAR**  
**RAW**  
**MANUKA**

\*also found in bread, wine, soya, beer

28

### Composition: Over the Counter

The US Food and Drug Administration (FDA) has approved several honey-based products (human and animal). Manuka honey from nectar of tree flowers *Leptospermum* (Australia and New Zealand)



MGO - dihydroxyacetone conversion, is in high concentration in nectar of Manuka flowers' nectar

Honey based

- gels
- dressings
- ointments
- creams
- lozenges
- syrups
- eye drops



Wound treatment, digestive problems, cough, sore throat and acne

Appl. Sci. 2021, 11, 5159

29

29

### Multiple Choice Question #3

The low pH and antioxidant activity of honey is primarily due to:

- a. Potassium
- b. Proline
- c. Dextrose
- d. Gluconic acid

30

30

## Outline

### Facts About the Bee and Honey

#### Medicinal History

- Egypt
- Greece
- Roman
- Christian
- Islam
- Aryurveda

#### Composition

#### Properties

#### OTC Products

### Conditions Treated

- Wound healing
- Anti-microbial
- GI diseases
- CVD
- Diabetes
- Asthma
- Cancer

### Adverse Effects

- Infantile Botulism

### Biologic Properties

- Anti Microbial
- Anti oxidant
- Anti inflammatory
- Apoptosis
- Prebiotic

### Other Bee Products

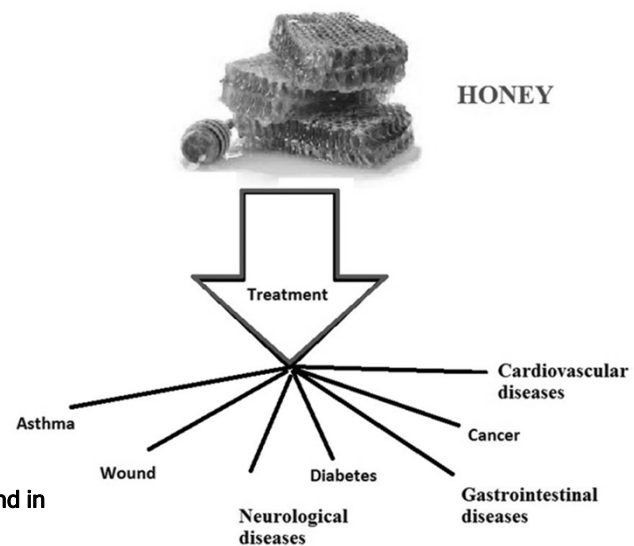
- Pollen
- Bees wax
- Propolis
- Royal Jelly

### Summary and Conclusions

31

31

## Efficacy of Honey in Diseases and Conditions\*



**\*results primarily from in vivo animal models and in vitro cell culture studies**

Samarghandian S, Farkhondeh T, Samini F. Honey and health: A review of recent clinical research. Phcog Res 2017;9:121-7.

32

32



## Conditions and Diseases treated

### Wound healing/management

- rapid clearance of infections
- debridement of wounds
- suppression of inflammation
- minimization of scarring
- stimulation of angiogenesis
- tissue granulation and epithelium growth
- insect bites, burns, skin disorders, sores, boils
- radical surgery for cancers

### Pediatric Care

- skin damage near stomas

### Gastrointestinal diseases

- Bacterial and rotavirus infection
- Diarrhea and gastroenteritis
- Constipation
- Peptic ulcer
- Oral health

33

33

### Diabetes type I and type II

- adjunct to standard antidiabetic drugs
- dramatically lower glycemic index than with sucrose or glucose
- reduces postprandial glycemic response
- lowering the glucose serum concentration

### Neurological diseases

- Polyphenol ingredients of honey quench biological ROS that lead to neurotoxicity, aging, and the pathological deposition of misfolded proteins, including amyloid beta.

### Cancer

- Apoptosis, antimutagenic, antiproliferative, and anti-inflammatory pathways.

### CVD

- Scavenging radical species, suppressing lipid peroxidation, strengthening enzymatic and non-enzymatic antioxidant systems and stimulating/inhibiting proinflammatory markers.
- Atherosclerosis

### Asthma

- Coughing sedative
- Pharyngitis/cough

34

34



Asthma and Allergy  
Foundation of America

***Does eating honey desensitize your body to pollen  
and improve allergy symptoms?***

***Need eat honey found in local area?***

- Honey does not help with allergies. Bees eat nectar/gather pollen from annuals/perennials/vegetables/fruit trees
- Not the same pollen responsible for allergies (trees, grasses, and weeds)
- Very little of these common pollen allergens would make it into honey
- Pollen loses its immunogenicity
- Pollen digested by bees and humans; pasteurization
- Don't ingest enough intact pollen for desensitization

<https://community.aafa.org/blog/aafa-explains-can-honey-help-my-seasonal-allergies>

35

35

Adverse effects: relatively free except for:

**DO NOT FEED HONEY TO CHILDREN YOUNGER THAN 1 YEAR OF AGE.**

Infant botulism

- Acute condition that affects infants (<1 year).
- Clostridium botulinum, an anaerobic Gram positive bacillus
- Microbial spores ingested, ideal conditions for germination in the colon
- Spores germinate into the vegetative form to produce toxins

Vehicle for infant botulism

- Contamination in a beehive, or stages of processing
- Considered one of the safest foods due to low pH, presence of organic acids, low Aw,
- Spores can survive this environment

The American Academy of Pediatrics (AAP) recommends:

- Do not give children under the age of 2 any added sugars
- Associated with higher risk of insulin resistance, prediabetes, and type 2 diabetes.

36

36

### Multiple Choice Question #4

**Honey can be given to children:**

- a. Younger than 1 year of age
- b. Younger than 2 years of age
- c. Over two years of age
- d. Once they are weaned

37

37

## Outline

### Facts About the Bee and Honey

#### Medicinal History

- Egypt
- Greece
- Roman
- Christian
- Islam
- Aryurveda

#### Composition

#### Properties

#### OTC Products

### Conditions Treated

- Wound healing
- Anti-microbial
- GI diseases
- CVD
- Diabetes
- Asthma
- Cancer

### Adverse Effects

- Infantile Botulism

### Biologic Properties

- Anti Microbial
- Anti oxidant
- Anti inflammatory
- Apoptosis
- Prebiotic

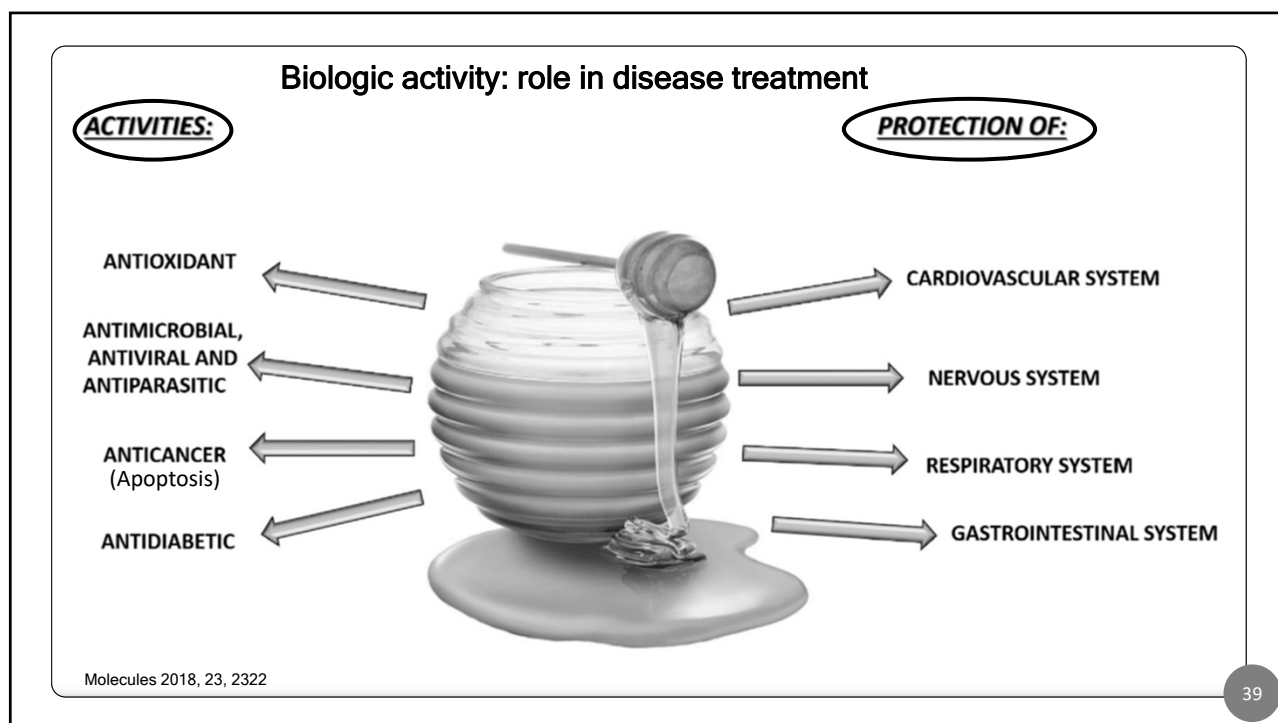
### Other Bee Products

- Pollen
- Bees wax
- Propolis
- Royal Jelly

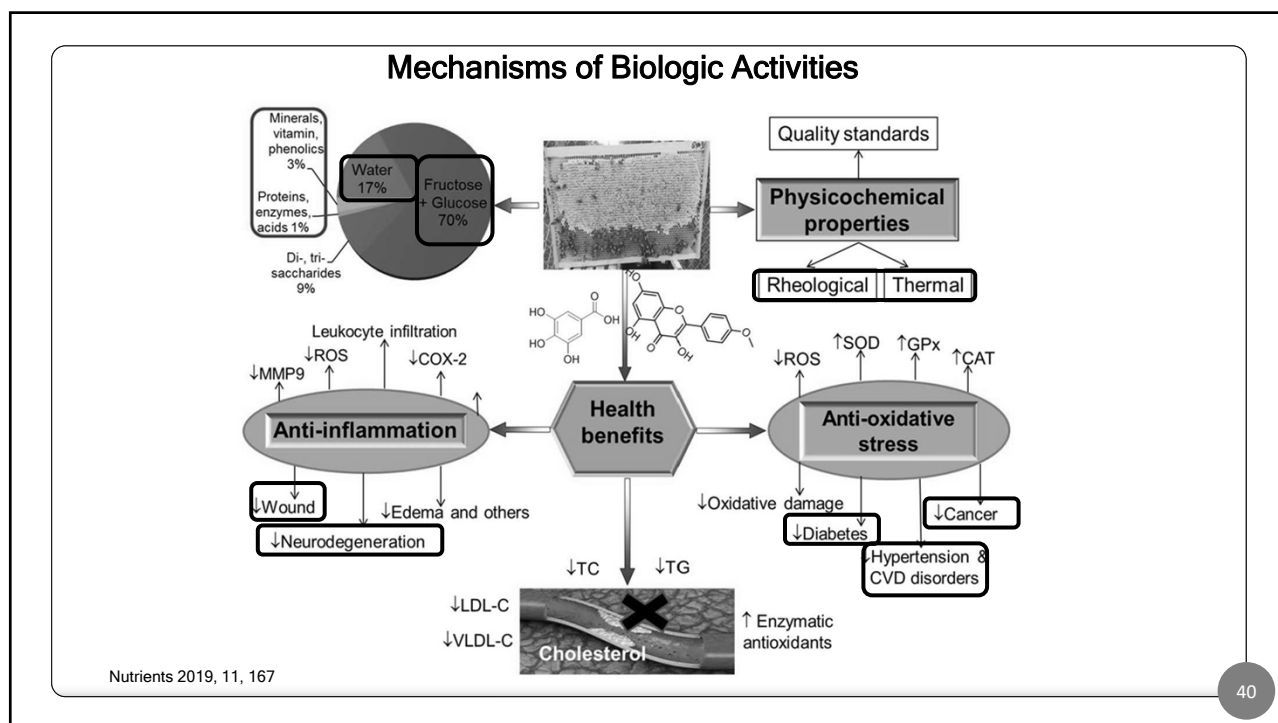
### Summary and Conclusions

38

38



39



40

## Biologic Properties of Honey\*

### Antimicrobial

- ~60 species of bacteria; aerobes and anaerobes, gram-positives and gram-negatives
- MIC range from 1.8% to 10.8% (v/v), i.e. sufficient antibacterial potency
- Does not lead to development of antibiotic-resistant bacteria
- Used continuously
- Anti bacterial activity due to
  - Dehydration of bacteria
  - Acidity (pH 3.2 - 4.5)
  - H<sub>2</sub>O<sub>2</sub>
  - Phytochemicals

### Antioxidant

- Sterilize the wounds, stimulate tissue re-growth, reduce edema, scar formation
- Simple wounds, burns, diabetic foot ulcers, pressure ulcers.
- Darker honey (e.g., Manuka) has higher value of antioxidant
  - antioxidant enzymes
  - phenolic compounds

\*results primarily from in vivo animal models and in vitro cell culture studies

41

41

### Apoptotic activity

Indicated to prevent cell proliferation, induce apoptosis, modify cell cycle progression, cause mitochondrial membrane depolarization in several types of cancer cell lines

### Prebiotic

High content of oligosaccharides - substrate for the growth of prebiotic microorganisms

### Anti inflammatory

Phenolic content in honey - anti-inflammatory effect  
 Suppress cyclooxygenase - 2 and/or inducible nitric oxide synthase

42

42

## In Sum

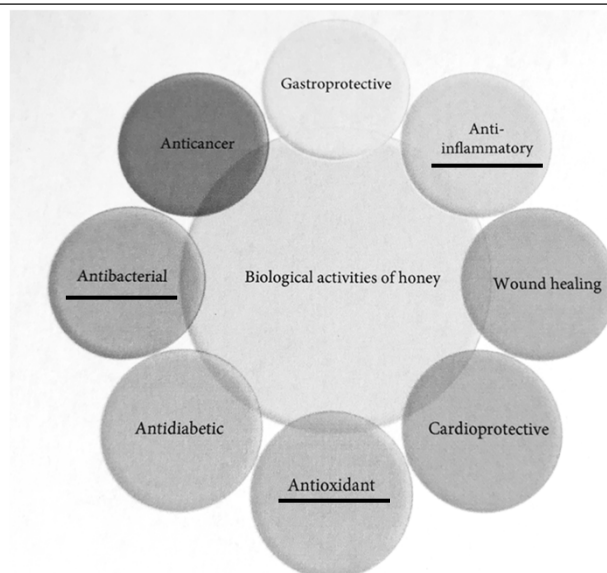


FIGURE 1: Various types of biological activities of honey products.

Hindawi Oxidative Medicine and Cellular Longevity Volume 2017, Article ID 1259510

43

43

## Outline

### Facts About the Bee and Honey

#### Medicinal History

- Egypt
- Greece
- Roman
- Christian
- Islam
- Aryurveda

#### Composition

#### Properties

#### OTC Products

### Conditions Treated

- Wound healing
- Anti-microbial
- GI diseases
- CVD
- Diabetes
- Asthma
- Cancer

### Adverse Effects

- Infantile Botulism

### Biologic Properties

- Anti Microbial
- Anti oxidant
- Anti inflammatory
- Apoptosis
- Prebiotic

### Other Bee Products

- Pollen
- Bees wax
- Propolis
- Royal Jelly
- Venom

### Summary and Conclusions

44

44

### Apitherapy from other Bee Products\*:

Pollen: protein; antifungal, antimicrobial, antiviral, anti-inflammatory, immunostimulating, and local analgesic

Bees Wax: lowering cholesterol and for relieving pain. Used for swelling, ulcers, diarrhea, hiccups

Propolis: resins, wax; gastrointestinal disorders, allergies, and gynecological, oral, dermatological conditions

Royal Jelly: water, protein, sugars: reproductive health, neurodegenerative disorders, wound healing, aging

Venom: protein; injected at traditional acupuncture point. anti-inflammatory properties, skin health, rheumatoid arthritis and chronic pain

#### Allergic reactions to bee products

\*results primarily from in vivo animal models and in vitro cell culture studies

45

45

### Multiple Choice Question #5

Apitherapy from \_\_\_\_\_ has been approved by the FDA:

- a. Propolis
- b. Royal jelly
- c. Pollen
- d. Honey

46

46

## Summary and Conclusions

- Natural product
- Bioactive compounds
- Oxidative Stress, low pH leading to antibacterial activity
- Food and/or a sweetener
- Medicinal use in stimulating healing of wound
- Treat other diseases and conditions
- Potential use for other bee products

47

47

## References

- Cianciosi, D. Phenolic Compounds in Honey and Their Associated Health Benefits: A Review *Molecules* 2018, 23, 2322.
- Eteraf-Oskouei T, Najafi M. Traditional and Modern Uses of Natural Honey in Human Diseases: A Review. *Iran J Basic Med Sci*; 2013; 16: 731-742.
- Fratini, F. et al Beeswax: A minireview of its antimicrobial activity and its application in medicine ini et al./*Asian Pacific Journal of Tropical Medicine* 2016; 9(9): 839-843
- Hossain, MD Lokman Honey-Based Medicinal Formulations: A Critical Review. *Appl. Sci.* **2021**, 11(11), 5159
- Khan, IU. Medicinal Properties of Honey: A Review *Int. J. Pure App. Biosci.* 2 (5): 149-156 (2014)
- Komosinska-Vassev, K. Bee Pollen: Chemical Composition and Therapeutic Application. *Evidence-Based Complementary and Alternative Medicine* Volume 2015, Article ID 297425
- Nguyen HTL. Honey and Its Role in Relieving Multiple Facets of Atherosclerosis *Nutrients* 2019, 11, 167 1-22
- Ranneh et al. Honey and its nutritional and anti-inflammatory value *BMC Complementary Medicine and Therapies* (2021) 21:30.
- Samarghandian S et al. Honey and health: A review of recent clinical research. *Phcog Res* 2017;9:121-7.
- Varničić M. and Sustainability of Electroenzymatic Process for Glucose Conversion to Gluconic Acid. *Catalysts* **2020**, 10(3), 269.
- Visweswara RP. ; Propolis, and Royal Jelly: A Comprehensive Review of their Biological Actions and Health Benefits *Hindawi Oxidative Medicine and Cellular Longevity*; Volume 2017, Article ID 1259510.
- Wehbe, R. Bee Venom: Overview of Main Compounds and Bioactivities for Therapeutic Interests *Molecules* 2019, 24, 2997;
- Weis et al; An overview about apitherapy and its clinical applications. *Phytomedicine Plus* Volume 2, Issue 2, May 2022,

48

48



