CoDreams

Honey Demystified

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Agenda

- Honey - introduction
- Honey & bees
- Is honey a healthy alternative to sugar?
  - Should health conscious people consume honey & how much?
  - Should diabetics consume honey?
- What are the different varieties of honey (naturally)?
- What are the different varieties of honey (commercially)?
- How to judge the quality of honey?
- How long can honey be stored?
- What are the therapeutic benefits of honey?

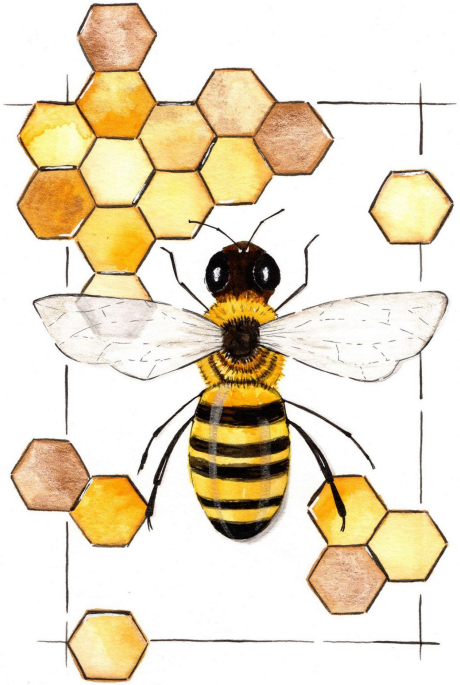
Honey - Introduction

- Honey is the sweet thick liquid that bees prepare for their own use but is robbed by humans
- The practice of collecting honey is considered as old as 8000 years
  - A rock painting in a cave in Valencia, Spain, dating back at least 8,000 years, depicts humans collecting honey from a wild bees' nest
- References are found throughout the world, about use of honey by humans since ancient times:
  - in both the Vedas and the Ayurveda texts
  - In Ancient Egypt, Ancient Greece & Early Christians

Ref: [1], [2]

Honey & Bees

- Process of making honey
  - Bees collect sugar-rich flower nectar & keep it in their honey stomach (The nectar's water content is 70 - 80%)
  - Enzyme action breaks down sugar into glucose & fructose
  - After enzyme action from series of bees, honey is stored in honeycomb cells (water content is 50 - 70%)
  - Bees use body heat & flutter their wings to evaporate water from the honey (such that water content is reduced to ~ 18%)
  - Then bees cap the cells with wax to seal them
- Bees produce honey for their long-term food supply
  - For rainy season & winters



Ref: [1], [2]

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Is honey a healthy alternative to sugar?

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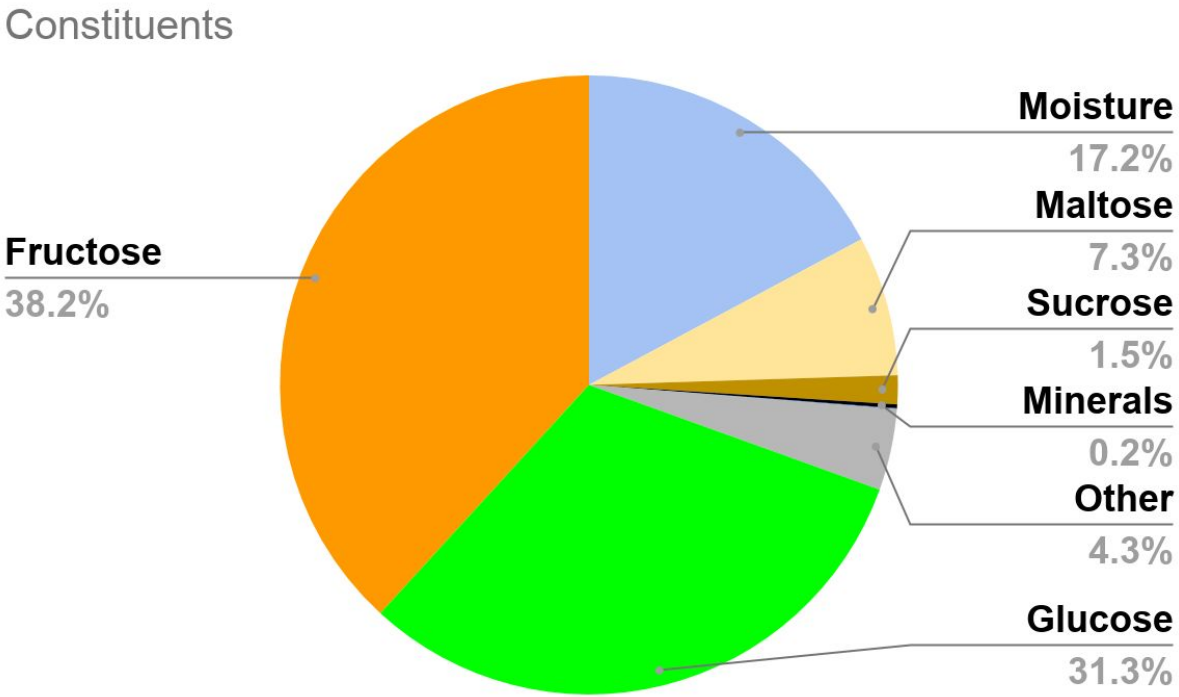
Composition of honey



- Fructose & Glucose are the key constituents of honey
- Moisture content of honey is quite low, which makes it thick
- It has trace minerals like Potassium, Chlorine, Sulfur, Calcium, Sodium, Phosphorus, Magnesium & Iron
- It also has organic acids, like formic acid, acetic acid, lactic acid & others
- It has roughly 0.04% of protein content

Ref: [3]

Is honey a healthy alternative to sugar?

Digestion of glucose, fructose & sucrose by human body

Glucose

- From the stomach it goes to small intestines & is absorbed in blood.
- When glucose increases in blood, the pancreas releases insulin, so that the glucose can be absorbed by body cells.
- As a result, in a healthy being, the surge in blood glucose will reduce & body cells will gain energy from the glucose.
- However, those who consume excess sugar or have a weak pancreas, end up with excess amount of glucose in blood arteries & that further causes inflammation in the arteries.

Fructose

- From the stomach it moves to the small intestine and then the liver secretes enzymes for its digestion.
- Unlike Glucose, Fructose is not quickly absorbed in blood, rather Liver enzymes convert it into cholesterol and triglycerides, which can cause fatty liver disease.
- However, if fructose is coming for digestion along with fibre of fruits, then it is not released too quickly to the small intestine and liver doesn't have to secrete that many enzymes and hence no significant negative impact by consuming fructose along with fibres.

Sucrose

- Sucrose is a compound which has one-part glucose and other fructose
- In small-intestine, sucrase enzyme breaks down sucrose into glucose & fructose.
- Then glucose goes in blood & triggers insulin secretion from Pancreas
- And fructose-part triggers secretion of the Liver enzymes and results into fat, cholesterol, etc.

Ref: [4]

Is honey a healthy alternative to sugar?

- In simple words,
  - Honey has 38% fructose & 31% glucose
  - Fructose doesn't cause immediate insulin surge but it has significant ill effects if consumed in excess
  - Fructose is better than glucose/sucrose only if it is consumed along with fibres of fruits and in moderation

Now, we answer our questions:

- Should health conscious people consume honey & how much?
  - Honey should be consumed only in moderation, otherwise it has its ill-effects
- Should diabetics consume honey?
  - Honey may not be as bad as glucose/sucrose for diabetics because it doesn't require that much insulin (because its glucose content is much less - 31%)
  - However, it can only be taken occasionally in moderation (preferably only for any medicinal use)

Ref: [11]

What are the different varieties of honey (naturally)?

What are the different varieties of honey (naturally)?

Source of nectar

- Colour, flavour, fragrance & consistency of honey can vary due to the source of the nectar collected by the bees
  - Colour: yellow, yellow-green, gold, amber, red-brown, dark-brown to nearly black
  - Flavour: sweet, mild-spicy to bitter
  - Similarly its fragrance & consistency also varies
- Some of the famous varieties of honey characterized by their floral source
  - Manuka honey, Tupelo honey, Eucalyptus honey, Clover honey, Alfalfa honey, etc.
  - Mustard honey, Lotus honey, etc.
- Apart from floral sources, bees make honey from honeydew as well
  - Honeydew is an excretory product of several species of insects that suck plant juices
  - When bees gather honeydew & store it, it becomes honeydew honey
  - Honeydew honey is darker in colour, as compared with honey from floral sources

Ref: [1], [3]

What are the different varieties of honey (naturally)?

Breed of bees

- Honey varies in taste, colour & qualities based on the breed of honeybees

Maksika
(Apis mellifera)

Bhramara
(Xylocopa)

Pauttikka
(Apis dorsata)

Other varieties:

- Ksaudra
- Chatra
- Arghya
- Auddalaka
- Dala

- Their effects differ and ‘Maksikam’ is considered medicinally the best
- Maksikam/Dalam is easy-to-digest, whereas Bhramaram/Chatram is heavy-to-digest
- Maksikam clears the channels, whereas Bhramaram blocks the channels

Ref: [5]

What are the different varieties of honey (commercially)?

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Raw, Filtered & Pasteurized

Raw Honey

Filtered & Pasteurized Honey

What are the different varieties of honey (commercially)?

Some background

- Pollens
  - When bees collect plant nectar & make honey, few tiny pollens also get into the honey. This pollen content carries antioxidant properties. Moreover, this pollen content is instrumental to determine the source of nectar, through (melissopalynological) tests. Therefore, absence of pollens also indicate the possibility of adulteration with invert syrup.
- Yeast spores
  - Beehives have yeast spores, therefore honeycombs also have it. Yeast is a kind of fungus. Honey is capable of neutralizing all fungal growth by absorbing its all water content. However, Yeast spores are already dry. Honey doesn't let it grow into mature form but it survives in spore form. Therefore, once honey is becomes old in storage & its antimicrobial properties diminish, then the Yeast starts growing by absorbing moisture from atmosphere.
- Bacteria spores
  - Similarly, bacteria spores also survive in honey. Human immune system is capable of killing Clostridium botulinum in its spore form. However, it can be dangerous for kids younger than one year because their immune system is not that strong yet.

Ref: [3], [6], [9]

What are the different varieties of honey (commercially)?

Raw, Filtered & Pasteurized

Features	Raw	Raw (basic filtration)	Raw with ultrafiltration	Filtered & Pasteurized
Retention of antioxidant properties (pollens)	Yes	Yes	No	No
Retention of antibacterial properties	Yes	Yes	Yes	No
Retention of Vitamins	Yes	Yes	Yes	No
Removal of bee parts	No	Yes	Yes	Yes
Removal of wax	No	Partly	Yes	Yes
Elimination of granulation	No	Partly	Yes	Yes
Elimination of Yeast spores (fermentation)	No	No	No	Yes
Elimination of Bacteria spores (Clostridium botulinum)	No	No	No	Yes

Ref: [3], [6], [9]

What are the different varieties of honey (commercially)?
Raw, Filtered & Pasteurized

- This indicates:
  - **Pasteurized honey** has very long shelf-life (because it neither granulates nor ferments). However, it is just a sweetener with no health-benefits
  - **Raw honey with basic filtration** seems to be the best choice, because it retains all the health-benefits along with minimum undesirable contents
  - However, the **Raw honey should not be stored for more than one year** and should be stored away from heat & light

Ref: [3], [5], [6], [9]

What are the different varieties of honey (commercially)?

Wild honey vs Apiculture honey

Wild honey is collected from beehives in forests, where bees collect multi-floral nectar

- It is honey in nature's purest form
- However, sometimes honey turns toxic when bees are proximate to tutu bushes (Coriaria arborea) and the vine hopper insect (Scolypopa australis)
  - Both are found throughout New Zealand
  - Bees gather honeydew produced by the vine hopper insects feeding on the tutu plant.
  - This introduces the poison tutin into honey

Apiculture honey is collected by beekeepers from the domesticated bees

- It is easy to identify the source of honey because mostly bees gather the nectar from the vicinity and hence more likely to be single-floral source
- Here, few beekeepers may manipulate the outcome by feeding sugar-syrup to the honeybees (when floral sources of nectar, are not available in the vicinity)

Ref: [2]

How to judge the quality of honey?

How to judge the quality of honey?

Moisture

- Percentage of moisture determines grade of honey:
  - Grade A : <= 18.6%
  - Grade B & C : upto 20%
  - Grade D : > 20%
- Possible reasons for more moisture
  - Extraction of unripe honey from honeycomb
    - In this condition honey has more tendency for granulation
    - More the percentage of moisture, sooner the honey ferments (with yeast spores)
  - Absorption of moisture from atmosphere by honey
    - When honey is not stored properly or stored for a long period, it absorbs moisture from atmosphere
    - It is indicated by foam or froth on the surface of honey (due to its fermentation by yeast)
- Heating can reduce moisture content and also neutralize yeast spores
  - Heating may neutralize health-benefits of honey but it kills yeast & eliminates granulation also

Ref: [3]

How to judge the quality of honey?

Enzymes

- Honey has several enzymes like
  - Diastase,
  - Glucose Oxidase,
  - Sucrase & others
- Content of Diastase / Sucrase in honey is popular for measuring its quality
  - Quantity of Diastase & other enzymes reduce with time (when honey is in storage)
  - Heat also destroys/weakens all the enzymes
- Greatly lowering of enzymes in honey reduces desirability of its use
  - It is considered one of indicators for acceptability of honey in Europe
  - It can be measured through lab tests
- Inhibine analysis (based on enzyme Glucose Oxidase) is also used to determine heating history of commercial honey

Ref: [3]

How to judge the quality of honey?

HMF (Hydroxymethyl furfural)

- HMF is formed from fructose in the presence of acid
  - Honey is acidic enough to facilitate this change
  - Its production is very slow in honey at room temperature
  - Its production increases with heating
- Presence of HMF in honey is indicator of its deterioration
  - due to heating or long period of storage
  - International market doesn't allow more than 40 mg/kg
  - It also indicates possibility of adulteration by invert syrup
- HMF formation is also referred as caramelization
  - It also causes an off-flavour
- However, it has been found that HMF can be dissolved using microwave heating (which is creates a new challenge in determining quality of honey)

Ref: [3], [7]

How to judge the quality of honey?

Pollens

- Pollens find their way into honey from the plants where bees collect nectar
  - Pollen analysis can be used determine floral source of nectar
  - It can identify region and country of origin
- Pollen analysis is not possible
  - if varied floral sources of honey are blended together
  - if all the pollens are removed through ultrafiltration
- In absence of pollens adulteration by corn syrup is also difficult to trace
- That's why, many markets only accept honey which contains pollen, so that its purity can be verified & floral source could be identified through pollen analysis

Bonus point

- Genuine honey forms a uniform solution when poured into clean water

Ref: [1], [6]

How long honey can be stored?

How long honey can be stored?

Fermentation, Granulation, Change in colour

- Pasteurized honey
  - doesn’t have health-benefit features
  - but heating eliminates fermentation & granulation
  - Therefore, pasteurized honey can be stored for long period
- Raw honey
  - has health-benefit features
  - but it does ferment & granulate with time, when stored
- Yeast spores
  - Honey is a thick concentrated liquid which is very low on water content
  - Therefore, bacteria & fungus don’t survive in it
  - However, yeast spores are already dry, therefore they don’t die inside honey
  - With time, while in storage yeast spores mature as they come in contact with moisture from atmosphere, and cause fermentation of honey
- When honey is stored for long period its colour also becomes darker

Ref: [3]

How long honey can be stored?

Fermentation, Granulation, Change in colour

- Raw honey should be stored
  - at temperature of 10^{o}C
  - away from light
- Honey shelf-life w.r.t. yeast spore density & moisture content
  - Honey with < 17.1% water will not ferment in an year, irrespective of yeast count
  - Between 17.1 & 18% moisture & yeast spores <= 1000 per gram (of honey), will be safe for an year
  - When moisture is between 18.1 & 19% & yeast spores must be <= 10 per gram (of honey) for safe storage
  - Above 19% water, honey can ferment even with only 1 yeast spore / gram (of honey)

Ref: [3]

What are therapeutic benefits of honey?

What are therapeutic benefits of honey?
Antibacterial

- Components responsible for antibacterial activity in honey
  - Acidity: Low pH prevents bacteria growth
    - Honey is fairly acidic & too high in sugar content, for growth to occur
    - However, it is neutralized by dilution with body fluids once consumed
  - Osmolarity: High sugar content of honey makes water unavailable to bacteria to grow
    - Bacteria added to honey die within a few hours or days, because it dries out the bacteria by pulling out most of bacteria's water content (in spore form bacteria can survive, but won't grow)
    - However, this factor is also neutralized once honey is consumed by humans, due to availability of body fluids
  - Inhibine effect: Glucose Oxidase generates H_2O_2 when diluted by water/fluids
    - This is a major antibacterial factor in raw honey (H_2O_2 inhibits growth of bacteria)
    - However, this antibacterial activity is sensitive to heat and light (because Glucose Oxidase gets neutralized by heat)
    - Honey from few floral sources have an enzyme called catalase. It neutralizes this antibacterial property
  - Other components (e.g. methylglyoxal):
    - Certain species of plants have other antibacterial substances which account for the antibacterial action

Ref: [3], [8]

What are therapeutic benefits of honey?
Antibacterial (contd.)

- Honey's action seems to be bacteriostatic rather than bactericidal
  - Bactericidal action: action of killing bacteria
  - Bacteriostatic action: action to stop bacteria from reproducing, while not necessarily killing them otherwise
  - However, if bacteria is kept in a state of bacteriostatic for a long period, its capacity to recover is lost
- Honey has a lot of variation in its antibacterial action
  - due to variation in its floral source
  - May be it is the variation in honey due to which microbes fail to develop resistance to it
  - However, due to the variation honey's antibacterial action, its strength cannot be reliably predicted (that hampers its use as antibacterial medicine)
- A few honeys are available with standardized levels of antibacterial activity
  - the best known is manuka (Leptospermum) honey as well as Tualang (Koompassia excelsa) honey (unlike glucose oxidase, their antibacterial properties are heat & light stable)

Ref: [3], [7], [8]

What are therapeutic benefits of honey?

Wound healing

- Since the ancient times, honey is known for its wound-healing activity
- Honey is very effective as dressing of wounds, burns, skin ulcers and inflammations
  - Clinical observations indicate reduced symptoms of inflammation
  - Medical-grade honey for wound/burn dressing;
    - Revamil Gel (Netherlands), Medihoney Gel (Canada)
- When honey it topically applied on a wound, its high viscosity helps to provide a protective barrier to prevent infection
  - Low pH level of honey and its high sugar content (high osmolarity) hinders the growth of microbes (e.g. non-peroxide honey, like manuka honey)
  - Also, the enzymatic production of hydrogen peroxide inhibits growth of microbes
- Honey also has immunomodulatory property
  - which helps in modulating immune response of the body

Ref: [1], [7], [12]

What are therapeutic benefits of honey?

Antioxidant

- In human body, when oxygen is metabolized, cells form byproducts called ‘free radicals’
  - Free radicals travel through the cell, disrupting the structure of other molecules and resulting in cellular damage.
- The body has its own mechanism to neutralize the ‘free radicals’ and maintain a balance between their creation & neutralization
- Due to stress & other lifestyle issues, this balance get disturbed & excess ‘free radicals’ result in diseases like cancer, cardiovascular diseases & neurological degeneration
- Antioxidants neutralize the ‘free radicals’
  - Antioxidants occur naturally in the body
  - Antioxidants can be consumed through the diet to block damage to cells

Ref: [10]

What are therapeutic benefits of honey?

Antioxidant (contd.)

- Like fresh fruits & vegetables, honey is also a source of antioxidants.
- Among the compounds found in honey; vitamin C, phenol compounds, catalase, peroxides, glucose oxidase enzymes have antioxidant properties
- Quantity of antioxidants in honey is almost double as compared to tomatoes & sweet corns
    - However, honey cannot be consumed in the similar quantities (as that of tomatoes & sweet corns)
    - But due to honey's pleasing taste, it may be more readily consumed by individuals reluctant to ingest plant-derived antioxidants
- Compared to sucrose (which has no antioxidant value), honey can be a flavourful, supplementary source of antioxidants

Ref: [10]

What are therapeutic benefits of honey?

Other benefits as mentioned in Ayurveda

- Honey is cooling, light to digest, drying/absorbent, appetizer
- Honey is good for eyes
- It breaks up hard masses & clears the channels
- It decreases kapha & aggravates vata
- It also decreases
  - hiccups, cough, vomiting
  - poison, worm, bleeding diseases, ulcers, skin diseases,
  - diarrhoea, urination problem

Without changing its own properties, honey carries the effects of the drugs added to it. It means it enhances the properties and actions of the substances with which it combines.

Word of caution

- It kills if used :
  - After heating it
  - During hot season
  - With hot foods
  - By those suffering from great heat
  -

} If honey has extract from a poisonous flower, then heat enhances its poisonous component

- No problem in using hot honey with enema & emesis therapies

Ref: [1], [5]

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