2.12 the constituents expressed in percentage terms of a typical sample of United Kingdom honey and an outline of the normal range of variation of its main constituents

Honey is an unstable solution of sugars and other substances. These others are either collected by the bees when they are gathering nectar from the flowers, for example pollen, enzymes, and yeasts, or added by the bees as the nectar is converted into honey in the hive.

The composition of the honey varies depending on soil, weather, type of plant producing the nectar and pollen, and / or the species of aphids producing the honeydew and what the aphids are feeding on.

Honey Constituents

Research indicates that bees prefer a well balanced diet and will prefer a good mixture of glucose, fructose and sucrose.

Honey when extracted contains particles, typically the largest being pollen grains. Unless passed through a fine filter pollen is found in all floral honeys.

Honey Constituents

Constituent	Typical Amount	Range
Carbohydrate Or stated as sugars: Fructose Glucose Sucrose Other Sugars	80% 38-40% 31-35% 1-3% 8%	78 - 86%
Water	17.5%	13 - 23%
Acids	0.5%	0.2 – 1%
Nitrogen	0.04%	0 – 0.13%
Ash	0.2%	0.02 – 1.03% (Celia Davis says 0.09 – 0.33%)
Enzymes	Not Stated	
Flavour and aroma constituents	Not Stated	
Breakdown Products	Not Stated	

3

Carbohydrates (sugars)

Taken together, sugars make up between 95 and 99% of the solids in honey. They can be classified by their chemical complexity into four classes:

Fructose

Glucose

Sucrose

Other Sugars

Other constituents include:

Water

Acids

Nitrogen

Ash

Enzymes

Flavour and aroma constituents

Breakdown Products

Carbohydrates (sugars)

Monosaccharides	Fructose and Glucose, typically in ratio 6:5 except in Rape honey Yates says: Glucose (dextrose) 35% Fructose (levulose) 40%	68 - 72%
Disaccharides	Sucrose 1-3% and Maltose ~7% (Yates says 4%)	8 – 10%
Trisaccharides	15 identified most important Melizitose	1 – 5%
Higher Sugars	A least 2 identified; contain 4 and 5 sugar molecules	< 1%

Glucose

Plants belonging to the Brassicaceae family (e.g. Brassica napus - rapeseed) yield nectar that is high in the monosaccharide glucose and is less soluble in water than other sugars and thus will crystalise / granulate rapidly with a fine crystal.

It therefore has the danger of granulating in the comb or later on in storage with fermentation issues.

Fructose

Also a monosaccharide however is twice as soluble in water than glucose. Darker honeys tend to have more fructose than glucose and if more dominant in the honey will granulate slowly, forming large crystals, these can be ‘gritty’ to taste. Honey produced from nectar collected from *Rubus spp* (brambles/blackberry) can produce up to 37.8% of fructose with 25.9% glucose.

Other sugars

Sucrose - a disaccharide, is found in nectar collected from long tubed flowers, for example clover. During ripening most of this is converted using the enzyme invertase into the monosaccharides.

Maltose, another disaccharide, is made up of two glucose molecules joined together. It occurs in honey as a secondary sugar when sucrose is inverted by the invertase enzyme.

Trisaccharide sugars - melezitose, erlose and raffinose are found in honeydew honey. The sugars found in honeydew varys with the species of the insect producing the exudate. Melezitose is less soluble in water than other sugars and thus will cause the honey to granulate rapidly. If however erlose dominates then the honey will not granulate.

The optical rotation of honey depends on its component sugars, their types and relative proportions. Using a polarimeter the axis of the light passed through a jar of honey will be rotated to the right (dextrorotatory) when the percentage of the glucose present exceeds that of fructose.

Water

Water

Below 17% concentration it is unlikely to ferment.

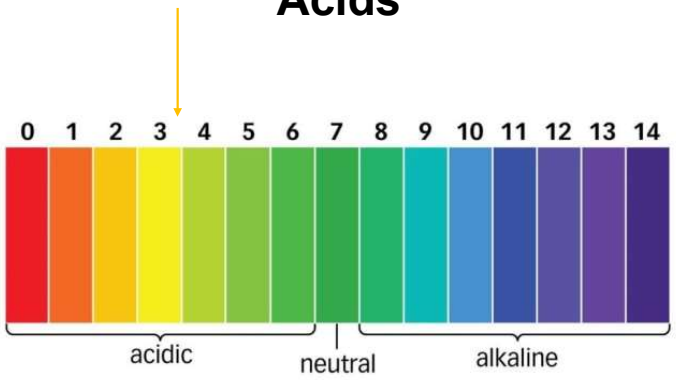
Heather and clover honeys have a higher water content, up to 23%.

Honeydew honeys typically have a lower water content. Generally the humidity during the honey flow will have an impact on the water content of the honey stored, it can be as low as 16.4% and as high as 23%.

When the honey is ripe in the cells the bees will cap it. As soon as you uncap the cells, as honey is hygroscopic the honey will absorb water from the atmosphere.

The crystallization of honey releases water molecules into the remaining liquid honey, thus increasing the percentage of water and thus the risk of fermentation by osmophilic (sugar tolerant) yeasts. These multiply, turning the sugars into alcohol and carbon dioxide, which in turn become acetic acid and water.

Acids



6

Acids

Although acids comprise only about 0.5% of honey they have important effects:

Reduce pH to 3.9 however it can range from 3.42 to 6.10.

Contribute to the stability of honey against micro organisms

Contribute to the flavour of the honey

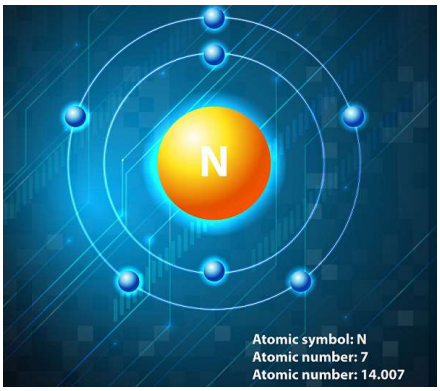
The main acid is gluconic acid which is produced by the action of the enzyme glucose-oxidase on glucose, producing gluconic acid and hydrogen peroxide when the honey is diluted.

Hydrogen peroxide is not sufficiently stable to remain for any length of time.

19 other acids have been identified, among which are formic acid, acetic acid, citric acid, lactic acid, butyric, malic, succinic and oxalic acid.

Honey dew honey rich in ash tends to be richer in acids.

Nitrogen



7

Nitrogen

40 – 65% of the nitrogen is in the form of proteins but there are some free amino acids. The proteins originate from pollen and from enzymes and other proteins introduced by the bees themselves.

The presence of proteins lowers the surface tension of honey and causes it to foam and produce scum.

The higher concentrations found in ling heather and manuka honeys produce thixotropic effects. Free amino acids react slowly with sugars at room temperature, more quickly at higher temperatures. This is thought to cause honey to darken on storage or when heated.

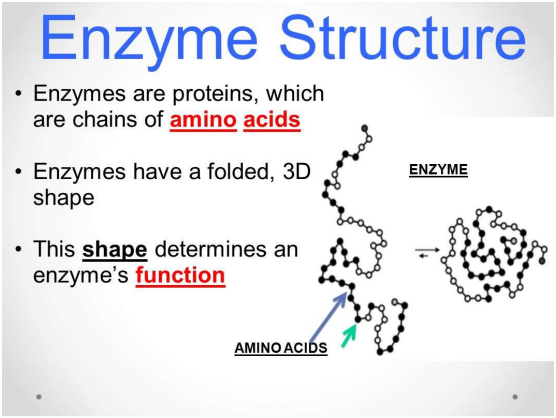
Ash

8

Ash is material left over when honey is heated to a high temperature and is caused by the presence of minerals. The element potassium is usually the largest component but there are very many more. Typically the more mineral elements present in the honey the darker the colour. Traces of iron are known to darken honeys. These minerals are derived from the soil on which the nectar producing plants grow. There will therefore big a very big variation on the element content in honeys. Ash content may vary from 0.02% to 1.2%.

Potassium, sodium, calcium, magnesium, iron, copper, manganese, chlorine, phosphorus, sulphur and silica have all been found in honey.

Enzymes / Proteins / Amino Acids



9

The thixotropic properties of heather (Culluna vulgaris) honey are due to the gel-sol-gel transformation of a protein. Honey contains small amounts of colloidally dispersed material (A system in which finely divided particles, which are approximately 1 to 1,000 millimicrons in size, are dispersed within a continuous medium in a manner that prevents them from being filtered easily or settled rapidly). The nitrogen content of this may show a protein content as high as 55 to 65% or as low as 15-25%. The colloids produce a state midway between a suspension and a true solution. The liquid properties are called 'sol' and the more solid states as 'gels'.

Enzymes are proteins, five are found in honey - catalase, glucose-oxidase, acid phosphatase and invertase. The enzyme activity of diastase is reduced in honey by heating or storage. Enzymes start to break down at temperatures above 45°C

Amino acids are the building blocks of proteins. 18 free amino acids are known to occur in honey, all in very small amounts. Proline is the major amino acid found. Others include: glutamic acid, leucine, tyrosine, glycine and lysine. Glycine is the simplest of all amino acids and is found in most proteins.

Enzymes / Proteins / Amino Acids

Invertase (sucrose)	Used by the bees to break sucrose down into glucose and fructose. Some enzyme activity remains in the honey. The reaction is reversible, i.e. invertase can cause glucose and fructose to recombine into sucrose. This may be the reason why all honeys contain a small amount of sucrose.
Glucose oxidase	Breaks glucose down into gluconic acid and hydrogen peroxide and is one of the major factors responsible for the antibacterial properties of honey.
Diastase (amylase) Average value of 20.8	Breaks starch down to simpler compounds. Its exact function in honey is unknown but bees use the enzyme to break pollen down.

Invertase (sucrose)
Used by the bees to break sucrose down into glucose and fructose. Some enzyme activity remains in the honey. The reaction is reversible, i.e. invertase can cause glucose and fructose to recombine into sucrose. This may be the reason why all honeys contain a small amount of sucrose.
Glucose oxidase
Breaks glucose down into gluconic acid and hydrogen peroxide and is one of the major factors responsible for the antibacterial properties of honey.
Diastase (amylase)
Average value of 20.8
Breaks starch down to simpler compounds. Its exact function in honey is unknown but bees use the enzyme to break pollen down.

Flavour and aroma constituents

11

Flavour and aroma constituents:

Many chemical compounds have been identified which are present in very small quantities but are responsible for giving honey its individual character. They mainly fall into 4 classes of chemical:

Alcohols

Aldehydes and ketones

Acids

Esters

The more volatile chemicals are lost quite quickly once the honey is removed from the hive and this is the main reason why the flavour of honey tends to decline as it ages. The subtle differences are therefore most powerful immediately the honey is removed from the hive.

The lighter the honey the less flavour is present, even this subtle flavour may be lost when the honey granulates, an almost infinite range of aroma and flavour variations exists.

They range from the strong and rather unpleasant aroma and taste of honey obtained from ivy, privet or ragwort, the characteristic smell and flavour of heather and lime tree honey to the very light flavour and aroma of the pale honeys. The flavouring and aromatic constituents (oils and gums) come from plant sources.

Breakdown products

The chemical composition of honey slowly changes over time. These changes are accelerated by heating. The most important breakdown product is hydroxymethylfurfural – HMF (formerly known as hydroxymethylfurfuraldehyde).

Allowable limits in honey are 40 ppm (40 mg/kg). Other breakdown products cause honey to darken slowly.

Vitamins

Small amounts of thiamine (B_1) riboflavin(B_2), ascorbic acid(C), pyridoxine(B_6), niacin and pantothenic acid are found in honey.

Colour

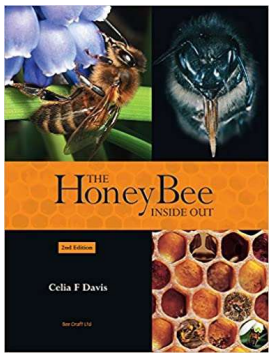
14

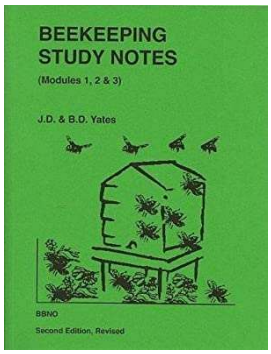
Colour

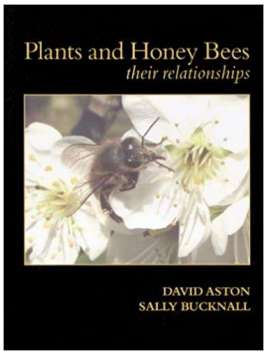
Floral honeys can range from a pale yellow to a deep amber. Honeys containing iron are usually deep shades of yellow. Carotenoids are a group of red and yellow pigments which occur widely in living organisms and may contribute to the differing colours of honey.

Honeydew honeys are usually darker than floral honeys, ranging from a darkish green to black. The darker colour may be due to the higher mineral content (ash) of the honeydew honey, around 0.726% compared to around 0.26% for floral honey. The green tinge may be due to the presence of algae. Age and heating darkens the honey.

References


THE
HoneyBee
INSIDE OUT
2nd Edition
Celia F Davis


BEEKEEPING
STUDY NOTES
(Modules 1, 2 & 3)
J.D. & B.D. Yates
BBNO
Second Edition, Revised


Plants and Honey Bees
their relationships
DAVID ASTON
SALLY BUCKNALL


MID BUCKS BEEKEEPERS
ASSOCIATION