The Story Of Pollen and Honey

Pollen and Honey as Food for Man

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Date pollen is used by some Egyptian Arabs as a supplementary food. The Chinese near Burma make pollen-honey cakes by kneading together a total of six alternate layers of pollen and sugared honey, to the right consistency, whereupon it is rolled out and allowed to dry for two hours. It is then cut into strips five inches long and left to dry for three to four days; it is then stored. These pollen-honey cakes are used as survival food during famines, during the monsoon seasons, and they also play a part in the daily diet as the equivalent of our candy or cake. Hunters carry these cakes and use them as the only food other than roots and fruits gathered in the jungle. These natives also make a honey "brandy".

Gathering and Storing

The foamy masses of reed pollen are raked and scooped from the back-waters of rivers and bayous where it is carried by the wind. The scoops are three-cornered fibre cloth nets, which when filled with the wet pollen, are wrung out. The pollen masses are spread on tables to dry and foreign particles are removed with tweezers. The pea-sized masses of pollen are crushed after drying, and packed in clay jars, sealed with mud and stored. Besides being used for making pollen-honey cakes, the pollen in powdered form is used as a medicine and as an antiseptic.

The waste matter at the bottom of bee hives is commonly eaten in Russia. This material, called honey scrap, is almost pure pollen.

The original Olympic contestants were required to eat natural honey to create a reserve of energy; this honey being unstrained, contained very large quantities of pollen.

Pollen Used Since Antiquity

Pollen is mentioned in the ancient texts of Persia, China and Egypt. In the Koran, Talmud and Bible, reference is made to both pollen and honey as ambrosia or heavenly food. Virgil, Hippocrates and Pliny considered that pollen contains the secret against old age.

In former times, the pollen-filled flower clusters of the Hala were gathered in February by Hawaiian maidens for the purpose of playfully belaboring the youths of their choice on the supposition that the pollen would act as a love charm. At times, this pollen was seriously used as an alleged aphrodisiac.

Pollen is an unadulterated natural product, and there is no danger of toxicity from the ingestion of pollen from supposedly noxious plants. Some people use about twenty grams of pollen daily as a normal food supplement; others use from one to three tablespoons per day. Pollens are generally bitter in taste, and except for the sweet kinds, there is left a somewhat disagreeable aftertaste. To improve palatibility, pollen may be combined with other ingredients such as honey, dates, raw sugar and other excipients.

Honey was one of man's first foods and remains as an important ingredient in his diet today. Honey is a natural, unrefined food, and the only unmanufactured sweet available in commercial quantities. Because of its high sugar content, honey has been used to preserve foods, especially fruits. Germs will not thrive in honey and it is therefore a safe and wholesome food also for infants and invalids. Honey may have therapeutic properties.

Honey has been variously called the nectar of the gods, the drink of the gods, and Aristotle labeled it the "dew distilled from the stars and the rainbow." Some ancients declared that the wonderful scent of honey could make men immortal.

Ceremonial Uses

In ancient ceremonies, honey has been used as a respectful offering to a guest or as a libation to a bridegroom on his first visit to his bride's father. In India, Egypt, Abyssinia and ancient Rome, certain medicinal properties were assigned to honey. About 18% of honey is water, but some honey will run as high as 20% of water by weight. Because honey is hygroscopic, it is useful in preventing baked goods from drying out.

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Honey Gathering

A honeybee could carry its own weight in nectar. A bee's stomach is pin-head in size, and sixty stomachfuls would provide enough nectar for conversion to one thimbleful of honey. A honey bee will visit as many as 1000 to 1500 single florets to obtain one stomachful. A worker bee produces about one-half teaspoon of honey in its four to eight weeks of life. It requires about three millions of separate bloom visits to furnish sufficient nectar for a pound of honey, and some colonies of bees store as much as two pounds of honey per day.

What Is Pollen?

Pollen consists of myriads of microspores formed in the anthers of flowering plants, and in the staminate cones of conifers and cycads. Rarely are individual spores large enough to be seen without magnification. A representative diameter for pollen grains is about one-half millimeter. A single strobile of pine may produce six million pollen grains and so also a single catkin of birch, or one flowering spike of ragweed. A head of rye may produce four million. A male yew tree shaken in February fills the air with "yew smoke." Lakes in the vicinity of pine woods may have their surfaces covered with a yellow film of pollen.

Pollination in flowering plants consists in the transfer of pollen from the anther of a stamen to the stigma of a pistil, which through the style, communicates with the ovary. This brings about fertilization of the ovules in the ovary and their subsequent development into seeds.

Many plants are pollinated by wind; others have this effected by water currents, and rain may pollinate still other plants.

Plants with showy or scented flowers with nectar are largely insect-pollinated. Insect pollinators include flies, beetles, bugs, wasps, bees, butterflies, moths, thrips. Still other flowers are pollinated by hummingbirds, sunbirds, honey eaters, lorikeets and honeycreepers. Bats and honey "mice" (marsupials) pollinate some flowers, and even snails have been observed transferring pollen.

Pollen Production

The annual pollen production of the USA is about the same as the annual honey production, namely about 80,000 tons. Most of this is bee-collected, and the rest is hand-gathered. A colony of bees may gather 60-120 grams of pollen per day or six pounds per hive in a year, but some exceptional colonies may bring 60-80 pounds into the hive in a single spring. A honey bee can carry its own weight in either pollen or nectar. Honey bees fly at a rate of about 10-15 miles per hour, work in a temperature range of 65-95° Fahr., and contact one blossom only to every twenty blossoms visited by a bumble bee. Honey-bee pollen is really a combination of pollen, nectar and saliva, and is therefore hygroscopic.

It has been estimated that some 75,000 tons of spruce pollen alone fall each year in Central and Southern Sweden combined. It has also been estimated that from four to seven million tons of pollen are shed throughout the world each year from all pollen-bearing plants combined.

Pollen in Animal Experimentation

Some laboratory investigations relate to the possible role of pollen fat in promoting fertility. Other work deals with such questions as growth promotion, and the use of pollen as sole source of nutrient for prolonged periods (six months).

Some animals have been fed bee-collected pollen as a portion of their diets in amounts varying from one part of pollen to 4,000 parts of other food, to one part of pollen in 100,000 parts of other food in order to study possible effects in delaying the appearance of tumors, and in the growth of mammary tumors. Cancer-infected animals have been given pollen extracts in studies concerned with cancer disappearance.

Experimental Therapeutic Uses of Pollen

Pollen has been and is currently under investigation in various clinics as experimental material in relation to constipation, chronic diarrhea, enteritis, colitis, flatulence, loss of appetite, toxin elimination, weight loss, diminished strength, anemia, rickets, growth, hemorrhage (cerebral, reticular, cardiac), premature ageing, neurasthenia, retarded mentality, mental lethargy in adults, psychosomatic conditions and allergy.

Bee-gathered pollen contains an admixture of nectar and saliva, and as such has been said not to be a cause of allergies when eaten. While amino acids are not the cause of pollinosis, there are some indications that they are part of a greater complex molecule causing the allergic manifestations. Daily dosages of pollen in allergic cases have consisted of about thirty-two grams.

Some work has been concerned with possible antibiotic and bacteriostatic properties of pollen with reference to the tubercle bacillus, to Escherichia coli, to Salmonella, and to other bacteria.

As a parallel to investigations involving the injection of antigens into the teat canal and the resulting prompt production of antibodies, other workers have injected pollen as antigen into the cow udder. This effort is directed toward secreting in the milk, blocking antibodies to ragweed pollinosis, which antibodies presumably would be absorbed following ingestion of the milk by the patient. It is hoped to develop an effective treatment for asthma, coryza and the associated eye-itching. Comb cell cappings which contain pollen, are being studied in connection with respiratory disease, hay fever, asthma and sinusitis.

Pollen is being studied as a possible useful ingredient of pharmaceutical preparations and cosmetics (e.g. orchid pollen).

Vitamins in Pollen and in Honey

A wide spectrum of Vitamins have been identified in pollen, including Inositol, Vitamin B-12 (Cyanocobalamin), Vitamin D, Biotin, Thiamin (9.2 micrograms per cent), Riboflavin (18.5 micrograms percent), Nicotinic acid (200 micrograms per cent), Folic acid (5 micrograms per cent), Vitamin B-6 or Pyridoxine (5 micrograms per cent), Vitamin C or Ascorbic acid (7,000 micrograms per cent), and Pantothenic acid (20-50 micrograms per gram). Rutin, plentiful in buckwheat pollen, may run as high as 16 milligrams per cent. Beehive stored pollen may contain 13% Rutin. A daily human consumption of 60-7-grams of pure pollen is regarded as safe as far as Rutin intake is concerned. Carotenoids (Provitamin A), present in the Lipochrome fraction, may range from 5,000 to 9,000 micrograms per cent. Vitamin E is found associated with the pollen fat of bee bread. Although no Vitamin K is present in mixed pollens, it is found in fermented pollen (bee bread), and is probably made by the bacteria which either accompany or assist in the fermentation of pollen into bee bread.

Vitamins to be found in honey include Thiamine or Vitamin B-1 (about 0.004 milligram percent), Riboflavin or Vitamin B-2 (about 0.05 milligram percent), Niacin (about 4 milligrams percent) and Ascorbic Acid or Vitamin C (about 10 milligrams percent).

Minerals in Pollen and in Honey

The total ash of pollen may vary from one to seven percent, with a mean of 2.7%, similar to that of grains and some other seeds. Minerals found are here given along with values obtained: Iron (0.01-0.3%; 0.6-7.1 mg percent of air dried pollen, the normal range for plant materials; 1-12% of total pollen ash), Copper (0.05-0.08% of total pollen ash; 1.1-2.1 mg percent of fresh pollen). Potassium (20-45% of ash), Magnesium (1-12% of ash), Calcium (1-15% of ash), Silicon (2-10% of ash), Phosphorus (1-20%) of ash), Sulphur (1% of ash), Manganese 1.4% of ash; 75 mg percent), Sodium, and Titanium. Although the presence of some of these, or increases in values actually present in pollen may be due to contamination with minerals of the dust of the air, soil and sprays, yet no great differences obtain in the percentage of ash between bee and hand-collected pollens.

The mineral content of honey runs about 0.18 gram percent of honey, and includes the elements of Iron, Copper, Sodium, Potassium, Manganese, Calcium, Magnesium, Aluminum, Phosphorus, Sulphur, Silicon, and Chlorine.

Protein and Amino Acid Content of Pollen

The protein content of pollen including some Peptones and Globulins present, ranges from 7-35% with an average of 20%; 40-50% of this may be in the form of free amino acids. The free amino acid content of whole dry pollen has been stated to range from 10-13%, which is from five to seven times as much as that to be found in an equal weight of eggs, cheese or beef meat. Some calculations indicate that while 35 grams of pollen per day would satisfy all protein requirements for man, as little as 25 grams per day would actually sustain him in terms of providing enough of each of the essential amino acids (total 6.35 grams, according to Rose), along with a variety of others.

Sample values obtained for the amino acid content of whole pollen are as follows (first eight acids are Essential): Tryptophan 1.6%, Lysine 5.7%, Methionine 1.7%, Threonine 4.6%, Phenylalanine 3.5%, Valine 6%, Isoleucine 4.7%, Leucine 5.6%, Cystine 0.6%, Arginine 4.7%, Histidine 1.5%, Glutamic acid 9.1%. Also present are Tyrosine, Serine, Proline, Hydroxyproline, Glycine, Aspartic acid, and Alanine. Apparently pollens contain the same number of amino acids, but there is a great variance in the quantity of each. Some amino acids may be abundant in certain pollens while barely detectable in others. Plant relationships are also indicated by the amino acid pattern.

Enzymes and Coenzymes in Pollen and in Honey

Various Enzymes have been identified in pollen, such as Catalase, Diastase, Amylase, Saccharase, Pectase, both Succinic and Lactic acid Dehydrogenase, Phosphatase, Diaphorase, Cytochrome systems, and Cozymase. A mixture of fresh pollens may contain from 500-1,000 micrograms of Cozymase per gram, comparing favorably with the amount in yeast. The alcoholic fermentation of pollen is identical with that of yeast.

The enzymes found in honey include Invertase which converts Sucrose into Levulose and Dextrose, Inulase which converts Inulin into Levulose, and Diastase which converts Starch to Maltose. Some of the enzymes come from the bee saliva.

Sugars and Other Carbohydrates in Pollen and in Honey

The Carbohydrates present in whole pollen include Gums, Pentosans, Starch, Sucrose or Cane Sugar, Levulose or Fruit Sugar, Glucose or Grape Sugar, Cellulose and Sporonine. Total sugars in pollen range from 30-40%; reducing sugars range from 7.5-40%; Glucose in pollen ranges from 25-48%, Non-reducing sugars range from 0.1-19%. In bee-collected pollen, if the Non-reducing sugars run about 2.71%, then the Reducing sugars in the same pollen may range from 18.82-41.21% with a mean value of 25.71%. But in hand-collected pollens, the values for the Reducing and Non-reducing sugars may be roughly the reverse. In one set of figures for air-dried, bee-collected pollen, the amount of Reducing sugars ranged from 20-40%, while the Non-reducing sugars ranged from 0-9% of pollen. In calculations for hand-collected pollen, Reducing sugars ranged from 0-7.5% and Non-reducing sugars ran up to 22%. Starches, sometimes combined with other carbohydrates, may run from 0-22% of pollen.

Sporonine comprises the extremely resistant exterior membrances of pollen. This very complex unextractable carbohydrate from pollen ranges from 7-57% of pollen in different species. The undetermined percentages of pollen which remain after the removal of water, ash, sugars, starch, protein and ether extracts, must be mostly the pollen shell or sporonine. For bee-collected pollen, this ranges from 21.65-35.87% with a mean of 28.55%; in hand-collected pollen it runs about 57.23%. A suggestion has been made for the possible application of this resistant residue, mostly sporonine, as an ingredient in plastics.

The Carbohydrates of honey include the higher alcohols (Mannitol, and Dulcitol), Gums and Dextrins (1.5%), Sucrose or Cane Sugar (1.9-2.0%), Dextrose or Grape Sugar (34%), Levulose or Fruit Sugar (40.5-60%), Maltose, and the Trisaccharide, Melezitose in conifer honey dew.

The Monosaccharides, Levulose and Dextrose comprise from 75-80% of the sugars in honey. Although Dextrose will crystallize out of most unheated honeys, Levulose will do so only with difficulty. Natural honeys that do not granulate include Tupelo, Mountain Sage, Sourwood and Gallberry. Levulose, also found in fruits, has been called the queen of sugars. It has a flavor, is twice as sweet as cane sugar, and is tolerated by diabetics.

Although not Carbohydrate in nature, the Aromatics in honey are the various Terpenes, Aldehydes and Esters, which in turn are derived from flavors in the flower nectar. The acid reaction of honey helps to bring out honey flavors and tastes.

Fats and Oils in Pollen

Although the ether extractives may range from 1-20% of pollens, yet the fats and oils alone may constitute only 5%. In some cases the fatty acids constitute 5.8% of pollen. Hexadecanol has been found in an amount of 0.14% of pollen weight. Alpha-amino-butyric acid has been identified in pollen fat. The unsaponifiable fraction of pollen weight may run 2.6%.

Pollen Pigments

The pigments of pollen are varied. Some are water soluble, others are fat soluble, and these account for the various colors of honey including the greens and ambers. The yellow of bee wax is a fat soluble pigment. Both chlorophyll and anthocyanins are absent from bee-collected pollen. The carotenoids are present in the pollen of insect-pollinated flowers but absent from the pollen of wind-pollinated species. Carotenes range from 50-150 micrograms per gram of pollen. In *Salix alba* the carotene content is mostly beta-carotene. Other carotenoids found in pollen include alpha-carotene, lycopene, zeaxanthin, and traces of crocetin, as well as xanthophyll which may run from 50 to 150 micrograms per gram of pollen. The lipochrome fractions are xanthophyll esters.

The carotenoids are usually combined with the outer layer of the pollen grain, the sporonine, but some may be bound to the protein of the pollen cell.

Pollens richest in carotene may contain twenty times as much as is present in an equivalent weight of carrots, a fact suggesting the use of such pollen as a source of Provitamin A and as a natural dye for foods.

Besides the class of carotenoids, there is another group of pigments found in pollen, the flavin pigments (flavones, flavonols). Cytochromes also occur in pollen.

Water and Content of Pollen

The water content of fresh pollens ranges from 3 to 20%.

Miscellaneous Materials in Pollen and in Honey

Analyses of pollen may show the presence of glycosides of quercetin, such as the rutin and quercetin of Forsythia, both of which may play a role in self-directed sterility. The methyl ester of quercetin in Crocus pollen is said to have sex-determining activity toward the bisexual cells of the green alga, Chlamydomonas. The glucoside of Isorhmnetin identified in pollen, may play a role in fertilization.

Pollen is found to contain Lecithin, Amines, Nuclein, Guanine, Xanthine, Hypoxanthine, Vernine, Waxes, Resins, Hydrocarbons (0.57% of pollen), Sterols (0.6% of pollen weight) and growth factors.

The wall of the pollen grain consists of cellulose, and of sporonine. Since pollen and microspores are homologous, the term pollenine is superfluous. The preservation of pollen in peat deposits appears due largely to the sporonine-bearing membranes. Pollen grains with thin Exine and with little or no sporonine, are not preserved in peat. Sporonine comprises about 21.9% of the pollen grains of *Pinus silvestris*. Sporonine is not related to lignins. Sporonine is highly unsaturated and combines with oxygen from 25-70%, to form peroxides. Half of the oxygen is present in the form of hydroxyl groups, the rest probably belongs to ether linkages.

Fungus spores are sometimes found intermingled with pollen.

Miscellaneous items in honey include some pollen grains, bee wax, albuminoids, chlorophyll derivatives, and all these together comprise about 4%.

Bee Bread

Bee-collected pollen contains nectar and saliva. This pollen mixed with honey, may be stored in the comb cells where it undergoes a lactic acid fermentation to produce bee-bread. Bee larvae fed pollen multiply their weight 1500 fold in six days. Bee-bread contains the Vitamins E and K, along with the many other materials found in unfermented pollen.

Air dried pollen wrinkles and its nutritive values decline with age, but bee-bread pollen after one or two years, resembles fresh pollen in both appearance and food values.

It is possible to imitate bee storage of pollen by making an artificial "bee-bread". This may be accomplished by dissolving 15 pounds of honey in 25 pounds of water which is brought to a boil and then cooled. To this solution is added 100 pounds of air-dried pollen. The resulting blend is mixed and kneaded with a suitable blender or accomplished by hand, and is then placed in a crock jar where it is lightly tamped. The contents are covered with a wooden disc supporting a stone weight. After standing at 96-97° Fahrenheit for four to six days, the disc and weight are removed, and the crock is sealed with a melted mixture of one part of bee wax and three parts of paraffin. The jar is then stored in a cool place.

Royal Jelly

Royal Jelly, consisting mainly of water, protein, carbohydrates, fat and vitamins, is a special food given to the very young worker larvae and to queen larvae. Most of the ingredients are made by bees from pollen. Royal Jelly contains seventeen times as much of the vitamin, Pantothenic acid, as is found in dry pollen. It appears that the vitamin is synthesized in process of making Royal Jelly. Other vitamins present are Thiamine, Riboflavin, Nicotinic acid and Biotin.

No Vitamin E activity has been noted in Royal Jelly. References have been made to an "R" factor in Royal Jelly which may be Rutin or Vitamin P (obsolete term). Some work points to the presence of bactericidal substances in Royal Jelly and possible therapeutic applications have been suggested for this substance.

An antibiotic, 10-hydroxy-D^2-decenoic acid, the major component of the lipid fraction of Royal Jelly, exerts activity against both bacteria and fungi.

Royal Jelly has been found experimentally to accelerate weight gains in rats, and the increments are credited to the readily available nutrients in the form of amino acids and the B-vitamins present.

Queen substance, which is produced in the mandibular glands of queen honey bees, along with queen scent, completely inhibits both queen rearing by worker honeybees, and the development of the ovaries of workers.

Cappings, Wax, Propolis and Brood Cocoon

Other bee products include the comb cell cappings (rich in pollen), bee glue or propolis, bee wax whose yellow color is due to fat-soluble pigments, and the brood cocoon. Possible therapeutic properties in these are under investigation, especially with reference to the cappings in relation to respiratory disease, hay fever, asthma, and sinusitis.

ANALYSIS OF POLLEN CONTENT

VITAMINS

1. Provitamin A (carotenoids)	5-9 mg %
2. Vitamin D	
3. Vitamin B-1 (thiamin)	9.2 micrograms %
4. Vitamin C (ascorbic acid)	7 milligrams %
5. Choline	
6. Inositol	
7. Vitamin B-12 (cyanocobalamin)	
8. Vitamin K	
9. Vitamin E	
10. Biotin	
11. Folic acid	5 micrograms %
12. Vitamin B-6 (pyridoxine)	5 micrograms %
13. Pantothenic acid	20-50 micrograms/gram
14. Rutin	16 milligrams %
Rutin in beehive pollen	13 %

MINERALS

1. Calcium	1-15 % of ash
2. Phosphorus	1-20 % of ash
3. Iron	1-12 % of ash
	.01-0.3 % of fresh pollen
	.6-7.1 mg % of air dried pollen
4. Copper	.05-.08 % of ash
	1.1-2.1 mg % of fresh pollen
5. Potassium	20-45 % of ash
6. Magnesium	1-12 % of ash
7. Manganese	1.4 % of ash
	75 mg %
8. Sodium	
9. Silicon	2-10 % of ash
10. Sulphur	1 % of ash
11. Titanium	

ENZYMES & COENZYMES

1. Diastase	5. Phosphatase	9. Cytochrome systems
2. Amylase	6. Catalase	10. Lactic dehydrogenase
3. Saccharase	7. Diaphorase	11. Succinic dehydrogenase
4. Pectase	8. Cozymase	

Note: The Cozymase in mixed fresh pollen runs about 0.5-1.0 milligram per gram, comparable to amounts in yeast.

PROTEINS, GLOBULINS, PEPTONES, AMINO ACIDS

(7-35 %, average 20%; 40-50 % may be free amino acids; 10-13% consists of amino acids in dry pollen)

35 grams of pollen per day can satisfy the protein requirements of man; 25 grams of pollen per day can sustain man because it contains the 6.35 grams as indicated by Rose, plus other amino acids.

Pollens contain the same number of amino acids but vary greatly in the quantity of each.

1. Tryptophan	1.6 %
2. Lysine	5.7 %
3. Methionine	1.7 %
4. Threonine	4.6 %
5. Phenylalanine	3.5 %
6. Valine	6.0 %
7. Isoleucine	4.7 %
8. Leucine	5.6 %
9. Cystine	0.6 %
10. Arginine	4.7 %
11. Histidine	1.5 %
12. Glutamic acid	9.1 %
13. Tyrosine	
14. Serine	
15. Proline	
16. Hydroxyproline	
17. Glycine	
18. Alanine	
19. Aspartic acid	

FATS & OILS - 5 %

1. Fatty acid (may be 5.8 %)
   Hexadecanol may be 0.14 % of pollen by weight.
   Alpha-amino-butyric acid is present in pollen fat.

2. Unsaponifiable fraction of pollen may be 2.6 % by weight.

FATTY ACIDS IN CONIFER POLLENS

Pseudotsuga dry pollen contains 0.76-0.89 % of fatty acid.
Major fatty acids are: Oleic, Palmitic, Linoleic.

Pinus dry pollen contains 1.25-1.33 % of fatty acid based on the dry weight of pollen.
Major fatty acids are: Linolenic, Oleic, Stearic.

Total list of fatty acids identified are:

1. Caproic (C-6)
2. Caprylic (C-8)
3. Capric (C-10)
4. Lauric (C-12)
5. Myristic (C-14)
6. Palmitic (C-16)
7. Palmitoleic (C-16, one double bond)
8. Unknown
9. Stearic (C-18)
10. Oleic (C-18, one double bond)
11. Linoleic (C-18, two double bonds)
12. Arachidic (C-20)
13. Linolenic (C-18, three double bonds)
14. Eicosenoic (C-20, one double bond)
15. Behenic (C-22)
16. Erucic (C-22, one double bond)

PIGMENTS

1. Xanthophyll (20-150 micrograms per gram of pollen)
2. Crocetin
3. Zeaxanthin
4. Lycopene
5. Carotenes (50-150 micrograms per gram)
   - Alpha carotene
   - Beta carotene
6. Chlorophyll, in hand-collected but not in bee-collected pollens
7. Anthocyanin, in hand-collected but not in bee-collected pollens

CARBOHYDRATES

1. Gums
2. Pentosans
3. Cellulose
4. Sporonine (7-57 % of pollen of various species; 28 % in bee-collected, 57 % in hand-collected pollens)
5. Starch (0-22 % of pollen
6. Total sugars (30-40 %)
   - Sucrose or cane sugar
   - Levulose or fruit sugar
   - Glucose or grape sugar
   - Reducing sugars (0.1-19%)

Bee-collected pollen: Non-reducing sugars, 2.71 %
Reducing sugars, 18.82-41.21 %
Mean, 25.71 %

Hand-collected pollen: Values are reverse of the above.

Air-dried bee pollen: Non-reducing sugars, 0-9 %
Reducing sugars, 20-40 %

Hand-collected pollen: Non-reducing sugars, up to 22 %
Reducing sugars, 0-7.5 %

WATER (3-20 % of fresh pollen)

MISCELLANEOUS

Waxes, Resins, Sterold, Growth Factors, Vernine, Guanine, Xanthine, Hypoxanthine, Nuclein, Amines, Lecithin, Glucoside of Isorhmnetin, Glycosides of Quercetin