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# Honey as Versatile Remedy: A Focus on Selected Honeys

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## Abstract

**Introduction:** Honey is one of the oldest traditional medicines. It has been well known that honey contains various components that could be use as treatment option. Most commonly studied honeys include gelam, kelulut, acacia, tualang and pineapple honeys. This review listed the five most commonly studied honeys, its properties and the study model involved.

**Results:** Honey has been reported to have multiple properties. Honeys were used to study their antimicrobial properties which includes antibacterial and antifungal, anti-inflammatory, antioxidant, anti-ulcer and wound healing, anticancer properties. Interestingly, tualang honey was used to study cognitive function and also used to study its ability to function as an adjuvant. Gelam honey and tualang honey both have been studied to determine their effects on fertility. From these five honeys reviewed, the most studied honey is tualang honey that showed significant impact not only on general health being and wound healoing, but also on cancer, inflammation, infection, oxidative stress, cognitive function as well as potential adjuvant. The studies were carried out on different study model from cell lines (*in vitro*) animal such as Sprague-dawley rats and Wistar albino rats and also human.

**Conclusion:** Honey is a natural compound with significant impact on health and general well-being. These effects might be due to its phenolics and flavonoid content as well as its involvement as signalling molecule that initiates the possible mechanism that needs to be further clarified in the future in treating and preventing diseases.

**Keywords: Anticancer; Antioxidant; Antimicrobial; Honey; Wound healing**

## Introduction

Honey is a well-known natural product that has been used since the ancient times as an alternative medicine as well as natural sweetener. The compositions of honey are mainly water and sugar (monosaccharides, disaccharides, oligosaccharides and polysaccharides) [1]. Honey also contains bioactive constituents such as amino acids, ascorbic acid, organic acids, proteins, trace elements, vitamins and Maillard reaction products[1-3]. The compositions varies due to the botanical origin of the honey[1].

Honey is widely known as antioxidant for containing high phenolics and flavonoids content, antibacterial agent for having low pH and enzymatic glucose oxidation reaction, anti-inflammatory agent for containing phenolics and slow absorption of honey leads to the formation of short-chain fatty acid fermentation agents. It is used to treat various conditions including infertility, respiratory and gastrointestinal symptoms.

This review aims to gather the properties of five honeys; acacia honey, gelam honey, pineapple honey, kelulut honey, and tualang honey and the associated diseases studied.

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**Table 1:** Acacia honey properties, associated diseased studies and the respective study model used

| Honey property | Disease associated | Study model | Reference |
|---|---|---|---|
| Antimicrobial* | Microbial infection | - | [4,5] |
| Wound healing | Corneal ulcer/abrasion | Cultured corneal fibroblasts; epithelial cells & keratocytes | [6-8] |
| Health being | Weight gain & cholesterol level | Sprague-dawley rats | [9] |

*antimicrobial = antibacterial + antifungal

**Table 2:** Gelam honey properties, associated diseased studies and the respective study model used

| Honey property | Disease associated | Study model | Reference |
|---|---|---|---|
| Anticancer* | Colon cancer; liver cancer; colorectal cancer | HT29 cell line; HepG2 cell line; HCT116 cell line; MCF-7 cell line; A549 cell line | [10-16] |
| Anti-inflmmatory | Inflammatory diseases; organ failure; infection; periodontitis; cancer | Sprague-dawley rats; Balb/c mice; New Zealand white rabbits; murine macrophage cell line RAW 264.7; HT29 cell line | [10, 17-20] |
| Antimicrobial* | Infection | Sprague-dawley rats | [4,5] |
| Antioxidant | Diabetes; hyperglycemia; oxidative stress/damage; | human diploid fibroblast; Sprague-dawley rats; HIT-T15 cells | [21, 23-28] |
| Radioprotectant | Oxidative damage | human diploid fibroblast | [16, 29] |
| Wound healing | Burn wound healing, diabetic wound healing, skin wound healing | Sprague-dawley rats; corneal keratocytes (New Zealand white rabbit) | [29-32] |
| Health being | Weight gain & cholesterol level; fertility | Sprague-dawley rats | [9, 33, 34] |

*anticancer = anti-proliferative, anti-tumor, chemopreventive, pro-apoptosis
*antimicrobial = antibacterial + antifungal

**Table 3:** Pineapple honey properties, associated diseased studies and the respective study model used

| Honey property | Disease associated | Study model | Reference |
|---|---|---|---|
| Anti-cancer* | Colon cancer | HT-29 | [15] |
| Antimicrobial* | Infection | - | [5, 35] |
| Antioxidant | Oxidative stress/damage | Human; | [36] |

*anticancer = anti-proliferative, anti-tumor, chemopreventive, pro-apoptosis
*antimicrobial = antibacterial + antifungal

**Table 4:** Kelulut honey properties, associated diseased studies and the respective study model used

| Honey property | Disease associated | Study model | Reference |
|---|---|---|---|
| Anti-cancer* | Colorectal cancer | Sprague-dawley rats | [37] |
| Antimicrobial* | Infection | - | [38-40] |
| Anti-ulcer | Gastric ulcer | Sprague-dawley rats | [41] |
| Health being | Sperm and testicular damage due to diabetes | Sprague-dawley rats | [42] |

*anticancer = anti-proliferative, anti-tumor, chemopreventive, pro-apoptosis
*antimicrobial = antibacterial + antifungal

**Table 5:** Tualang honey properties, associated diseased studies and the respective study model used

| Honey property | Disease associated | Study model | Reference |
|---|---|---|---|
| Adjuvant | Breast cancer; diabetes | Human MCF-7 cell line; MDA-MB-231 cell line, Sprague-dawley rats | [43-45] |
| Anticancer* | Breast cancer; cervical cancer; keloid | MCF-7 and MDA-MB-231; HeLa; Sprague-dawley rats; oral squamous cell carcinomas (OSCC) & human osteosarcoma (HOS) cell line; primary normal human dermal fibroblasts (pNHDF) & primary keloid human dermal fibroblasts (pKHDF) | [46-50] |
| Anti-inflammatory | Eye alkali injury; intestinal anastomosis wound healing | New Zealand white rabbits; Wistar rats; sprague-dawley rats | [51-53] |
| Antimicrobial* | Burn wound healing | Human; sprague-dawley rats | [39, 46, 54-57] |
| Antinociceptive | Pain; post-tonsillectomy pain | Human; sprague-dawley rats | [58,59] |
| Antioxidant | Corneal stem cell; diabetes; Oxidtive damage; environmental toxicants towards health of ovary; hypertension; menopause/ neurodegenarative diseases; neurodegenerative diseases; | Human corneal epithelial progenitor (HCEP) cells; sprague-dawley rats; spontaneously hypertensive (SHR) & Wistar-Kyoto (WKY) rats | [45, 51, 60-67] |
| Cardioprotective | Myocardial infarction | - | [68] |
| Cognitive function | Wistar albino rats | Human; sprague-dawley rats | [69-71] |
| Wound healing | Tonsillectomy wound healing; intestinal anastomosis wound healing | Human; Wistar rats; sprague-dawley rats | [52, 53, 55-57, 72, 73] |
| Health being | Fertility (spermiogenesis); menopause | Sprague-dawley rats | [74-78] |
| Photochemopreventive | Photocarcinogenesis | PAM212 mouse keratinocyte cell line | [79] |

*anticancer = anti-proliferative, anti-tumor, chemopreventive, pro-apoptosis
*antimicrobial = antibacterial + antifungal

## Discussion

The most commonly studied property is the anticancer activity of honey though its anti-proliferative, anti-tumor, chemopreventive and pro-apoptosis properties. Honey induces apoptosis in most types of cancer cells through depolarizing the mitochondrial membrane[80]. It increases caspase 3 activation and poly (ADP-ribose) polymerase (PARP) cleavage, modulates the expression of pro- and anti-apoptotic proteins, induces the expression of p53, caspase 3, and proapoptotic protein Bax and downregulates the expression of anti-apoptotic protein Bcl2[46].

As for the anti-inflammatory activity of honey, it has been proven that honey reduces the release of nitrous oxide, cytokines (TNF-α, IL-1β, IL-2, IL-6, and PGE2) and histamines which reduces inflammation and as well as pain[58,81]. Antinociceptive property of honey is due to its ability to reduce plasma prostaglandins such as thromboxane B2, PGE2 and PGF2a[58,82]. The low water content and low pH (acidic) of honey due to the formation of gluconic acid results to an environment that is not favourable for bacteria to grow thus contributing to its antibacterial property[59] apart from having high viscosity that limits the solubility of oxygen and substances. Apart from that, the enzymatic glucose oxidation reaction also contributes to the antimicrobial property of honey alongside with phenolics and flavonoids[83,84]. Phenolics and flavonoids also are responsible for not only the antioxidant properties of honey[1,84-89] but also the anti-inflammatory activity of honey[82].

The ability for honey to increase weight is unclear though some reported that the weight differences are not significant. It was suggested that it was due to the androgenic properties, since androgens exhibit anabolic activity apart from having some nutritive compounds[54,90]. Reports also showed that honey could increase the fertility in rats. However, the exact mechanism for redusing infertility by increasing sperm count was also unclear. It was hypothesised that antioxidant properties of honey plays an important role for spermatogenesis[35,74].

## Conclusion

It has been known that honey has various properties and has been used as alternative medicine for centuries. The properties of honey explored include anti-cancer, antimicrobial, antibacterial, antioxidant and antiinflammatory. Surprisingly, honey is also studied for its antinociceptive property and as adjuvant. Although some of the studies are still at preliminary stage, the significant differences showed that honey alters the mechanisms towards disease pathogenesis. This suggested that honey might also involved in modulating signalling molecules that involved in healing and disease prevention and treatment. More studies should be carried out to elucidate the actual compounds and mechanisms that give such results.

**Conflict of interest:** Authors declare that there is no conflict of interest.

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