



## Review Article

### TUALANG HONEY: COMPOSITION, PHYSIOCHEMICAL PROPERTIES AND CLINICAL IMPORTANCE

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#### ABSTRACT

Honey is a natural supersaturated sugar solution composed mainly of a complex mixture of carbohydrates and water. Honey composition is variable and depends primarily on its floral source. The composition and biological effects of honey is influenced by seasonal and environmental factors. Tualang honey is a multifloral wild honey produced by a kind of bees known as rock bees or *Apis dorsata*. This kind of bees build their hives on the *Kompassia excelsa*, the other name of tualang trees, which are located in the North- Western region of Malaysia. They are also found in Sumatra, Borneo, and South Thailand. Many previous researches have been carried out on tualang honey and they proved its beneficial effects in a wide range of clinical conditions. This review summarizes the physicochemical properties of tualang honey and its medicinal importance.

**Key words:** Tualang honey, Physicochemical properties, Clinical importance

#### INTRODUCTION

Honey is a natural supersaturated sugar solution composed mainly of a complex mixture of carbohydrates. It also contains water (20%) as well as minor but important components such as proteins, enzymes (invertase, glucose oxidase, catalase, and phosphatases), amino acids, organic acids (gluconic acid, acetic acid), lipids, vitamins (ascorbic acid, niacin, pyridoxine), volatile chemicals, phenolic acids, flavonoids, carotenoid-like substances, and minerals<sup>1</sup>.

Flavonoids and phenolic acids considered to be potential markers of honey's botanical origin. Phenolic acids are divided into two subclasses: substituted benzoic acids and cinnamic acids. From flavonoids, the honey contains the flavonols, flavones, and flavanones, which are similar to phenolic acids in their structure. Flavonoids and phenolic acids are important components as they contribute to the colour and taste of honey, and they also provide beneficial health effects to human<sup>2</sup>. Honey composition is variable and depends primarily on its floral source. The composition and biological effects of honey is influenced by seasonal and environmental factors<sup>3</sup>. Tualang honey is a multifloral wild honey produced by a kind of bee known as rock bee or *Apis dorsata*. This kind of bees build their hives on the *Kompassia excelsa*, the other name of tualang trees, which are located in the North- Western region of Malaysia. They are also found in Sumatra, Borneo, and South Thailand<sup>4</sup>. Tualang trees characterised by their height which can reach up to 250 feet, and more than 100 nests can be found on the same tree. The honeycombs can be up to six feet across, and a single comb can contain as many as 30,000 bees. From a single tualang tree 450 kg of honey can be obtained<sup>5</sup>.

#### HONEY IN ISLAMIC MEDICINE

The Islamic literatures considered honey as a healthy drink. The holy Qur'an vividly illustrates the potential therapeutic value of honey as Allah (SW) said:

"And thy Lord taught the bee to build its cells in hills, on trees, and in (men's) habitations; Then to eat of all the produce (of the earth), and find with skill the spacious paths of its Lord: there issues from within their bodies a drink of varying colours, wherein is healing for men: verily in this is a sign for those who give thought". Surah Al- Nahl. Verse 68, 69. Chapter 14.

Prophet Mohammad (SA) mentioned honey in his hadith and he has recommended its use for healing of diseases. Avicenna, one of the greatest Muslim physicians in the Islamic golden era, had also recommended honey as one of the best remedies in the treatment of tuberculosis<sup>6</sup>.

#### COMPOSITION AND PHYSICOCHEMICAL PROPERTIES OF TUALANG HONEY

Tualang honey characterized by its specific physical properties which include high acidity with a pH value of 3.55-4.00, high color intensity and 1.335 specific gravity<sup>5</sup>. Chemically, it contains phenolic acids and flavonoids. Gallic, syringic, benzoic, transcinnamic, p-coumaric, and caffeic acids constitute the phenolic acids of tualang honey. Whereas catechin, kaempferol, naringenin, luteolin and apigenin constitute its flavonoids components. Amongst the various types of Malaysian honey, tualang honey is the richest in phenolic acids, and flavonoid compounds which have strong free radical-scavenging activities<sup>2</sup>. Ahmed S et al. 2013 reported the presence of some compounds

that are specific to tualang honey among the other types of honey. stearic acids, 2-cyclopentene-1, 4,-dione, 2[3H]-furanone or dihydro-butylolactone, gamma-crotonolactone or 2[5H]-furanone, 2-hydroxy-2-cyclopenten-1-one, hyacinthin, 2, 4-dihydroxy-2, 5-dimethyl-3[2H]-furan-3-one, and phenylethanol, represent aforementioned compounds<sup>5</sup>. Table 1 summarizes the physical characteristics of tualang honey.

**Table 1: Physical characteristics of tualang honey**

Physiochemical properties	Tualang Honey
Appearance	Dark brown
Specific gravity	1.335
pH	3.55- 4.00
Moisture content	23.30%
Total Reducing sugars	67.50%
Fructose	29.60%
Glucose	30.00%
Maltose	7.90%
Sucrose	0.60%
Potassium	0.51%
Calcium	0.18%
Magnesium	0.11%
Sodium	0.26%
Carbon	41.58%
Oxygen	57.67%

## CLINICAL IMPORTANCE OF TUALANG HONEY

Honey is known by its medicinal importance and has been used since ancient times to treat several diseases<sup>7</sup>. Many previous researches have been carried out on tualang honey and they proved its beneficial effects in a wide range of clinical conditions.

### 1-Antibacterial activities

Tualang honey has good antibacterial activities, both bacteriostatic and bactericidal, and it is found to be effective against gram positive, as *Staphylococcus aureus* and *Staphylococcus epidermidis*, as well as gram negative bacteria, as *Escherichia coli*, *Pseudomonas aeruginosa* and *S. enterica Serovar Typhimurium*<sup>8</sup>. It exhibited variable activities against different microorganisms which suggests that tualang honey could potentially be used as an alternative therapeutic agent against certain microorganisms, such as *A. baumannii* and *S. maltophilia*<sup>7</sup>.

### 2- Antioxidant Activities

The presence of phenolic acids and flavonoids in tualang honey in high concentrations gives the tualang honey its important antioxidant properties<sup>8</sup>, which are higher than that of all other types of Malaysian honeys. The dark brown appearance of tualang honey, highest ferric reducing power values, combined with its highest concentration of phenolic acids and flavonoids prove its highest antioxidant properties<sup>1</sup>. These properties can give tualang honey important nutritional and health values<sup>9</sup>.

### 3-Wound healing properties

Many studies have been done previously on different types of wounds to determine the effectiveness of tualang honey in the healing process. Its effectiveness were clear in full-thickness as well as partial-thickness wounds. Tualang honey showed better results than hydrofibre silver and aquacel plain dressings in full-thickness burn wounds, both in wound size reduction and efficacy of healing<sup>8</sup>. It also limits the growth of partial-thickness wounds

infected with *Pseudomonas aeruginosa*, *Acinetobacter baumannii* or *Klebsiella pneumonia*<sup>10</sup>. In addition to its significant results in controlling of *Pseudomonas aeruginosa*-infected wounds<sup>11</sup>, and in the treatment of diabetic foot in patients suffer from diabetes<sup>12</sup>.

### 4- Antineoplastic and Antiproliferative Activities

The methanolic extraction of tualang honey has a potential effect as antiproliferative substance on keloid fibroblasts- Keloid is a type of scar which extends beyond the boundaries of the original wound<sup>13</sup>. Also it showed antiproliferative effect on oral squamous cell carcinomas and human osteo- sarcoma cell lines by inducing early apoptosis<sup>14</sup>. Tualang honey has a significant anticancer activity against breast cancer cells comparable to the effect of tamoxifen (TAM). Combination of tualang honey and TAM was more potent than either agent alone in inhibiting cell growth of both estrogen receptor-(ER) responsive as well as ER-nonresponsive human breast cancer cell lines via direct induction of caspase-dependent apoptosis and increasing the depolarization of the mitochondrial membrane. Potentiation of TAM effect by tualang honey may reduce the required effective dose of TAM with a resultant reduction in adverse effects of TAM<sup>15</sup>. Furthermore, tualang honey decreased photo-carcinogenesis caused by exposure to ultraviolet B radiation. The anti-carcinogenic effects are due to an attenuation of PGE-2 synthesis and prevention of the nuclear translocation of NF-κB in keratinocytes<sup>16</sup>. Figure 1 demonstrates the inverse relationship of honey and cancer<sup>17</sup>.

### 5- Reproductive benefits

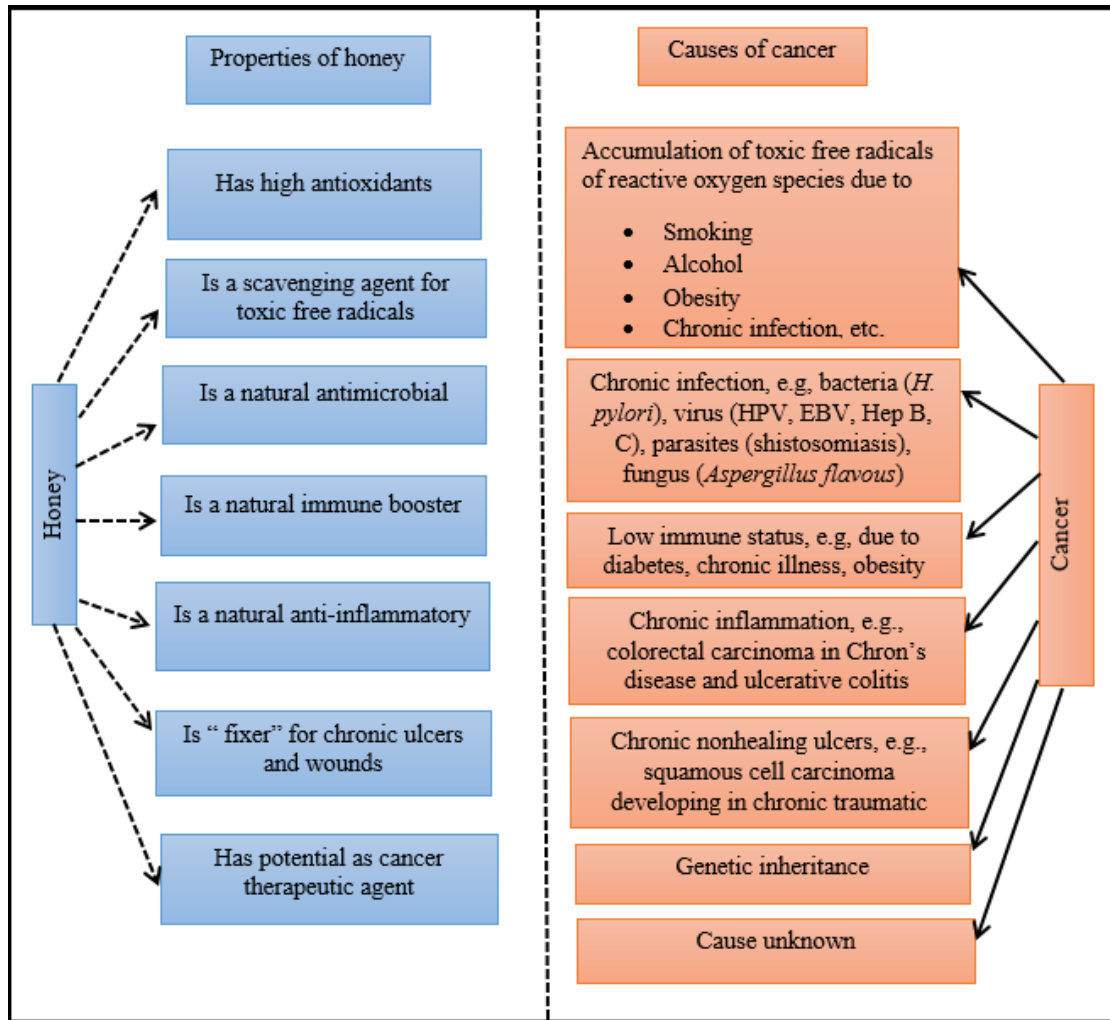
Tualang honey can protect against vaginal epithelial atrophy and uterine atrophy in ovariectomised rats (the animal model of menopause)<sup>18</sup>. It also can reduce testicular damage by reducing lipid peroxidation in rats exposed to oxidant cigar smoke, and it has a protective effect against cigar smoke-induced abnormal sperm parameters<sup>19</sup>. In addition, tualang honey showed clinically its ability to improve sperm concentration, motility, and morphology among oligospermic males<sup>20</sup>. Tualang honey has a marked role in reduction of Bisphenol A (BPA)-induced ovarian toxicity in prepubertal rat through decreasing follicular morphological abnormalities in the ovary and improving the normal estrous cycle<sup>21</sup>.

### 6- Anti-diabetic Activity of tualang honey

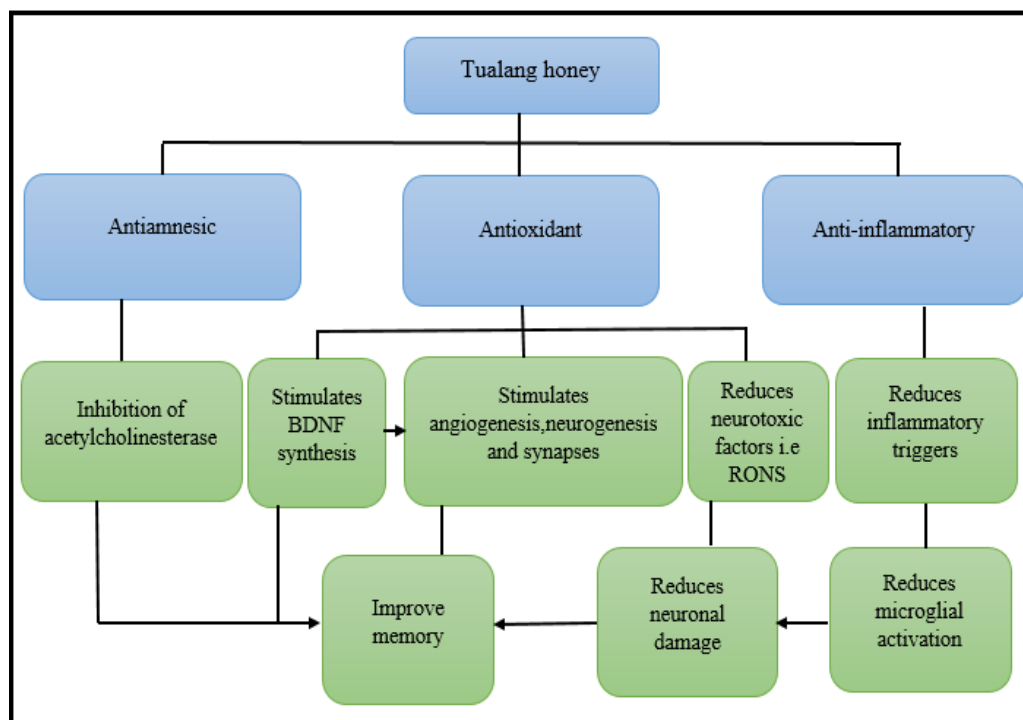
Tualang honey has an intermediate glycaemic index. In an experimental study, combination of tualang honey with oral hypoglycemic agents resulted in an improvement of glycemic control. Not just this but also resulted in an improvement of lipid and renal profiles which indicates its synergistic effect to oral hypoglycemic agents. This can suggest that the combination of honey with oral hypoglycemic agents may be a valuable adjuvant therapy to achieve and/or maintain glycemic control and possibly reduce or delay the onset of diabetic complications<sup>22</sup>.

### 7- Improvement of learning and memory

Tualang honey showed its ability to improve learning and memory in clinical<sup>23</sup> as well as experimental studies<sup>24</sup>. These activities of tualang honey can be attributed to its ability to stimulate the cholinergic system and improve the morphology of the brain. Also it could be due to the reduction of oxidative stress damage to the brain, and to stimulation of synthesis and secretion of brain-derived neurotrophic factor concentration. Furthermore, tualang honey may play a role in inhibition of active microglia and neuroinflammatory process<sup>4</sup>. Figure 2 illustrates the roles of tualang honey in learning and memory<sup>4</sup>.



**Figure 1: The inverse relationship of honey and cancer.**



**Figure 2: Roles of tualang honey in learning and memory.**

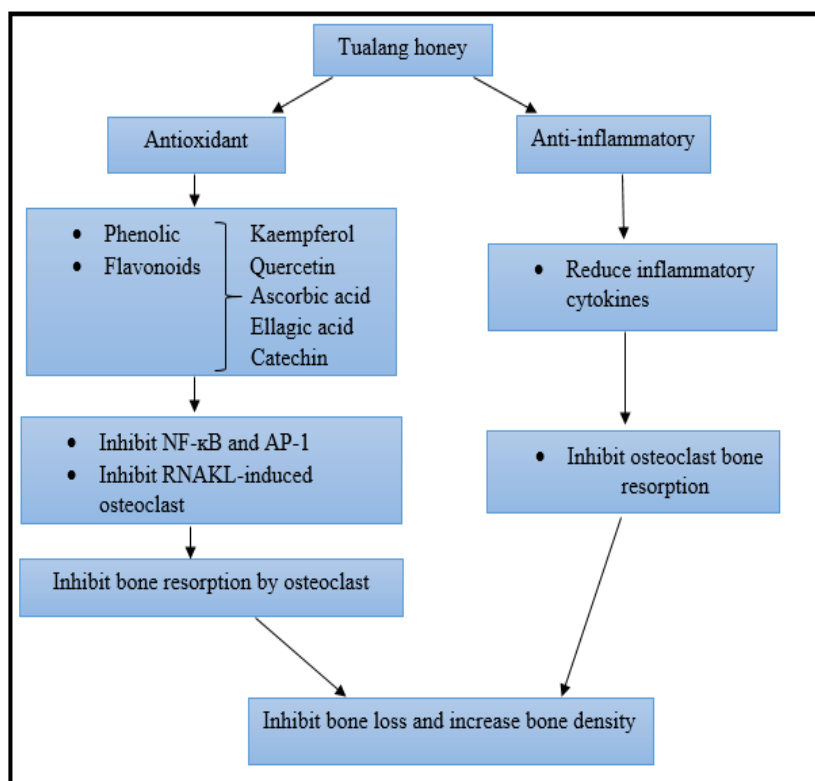


Figure 3: Antioxidative and anti-inflammatory actions of tualang honey on bone.

### 8- Anti-inflammatory activities

Tualang honey has anti-inflammatory activities<sup>25</sup>. This property of honey is due to its ability to reduce the level of prostaglandin E<sub>2</sub><sup>26</sup> and its inhibitory effect on nitric oxide<sup>27</sup>. Honey has anti-inflammatory effect not only in acute inflammation but also in chronic form of inflammation such as arthritis<sup>27</sup>.

### 9- Role of tualang honey in osteoporosis

Tualang honey showed its ability to increase bone density and restore osteoporotic bones in ovariectomized rats which could be attributed to the effect of gluconic acid and carbohydrate constituents of honey that may enhance calcium absorption in the bone of rats. Also it could be due to kaempferol (flavonoids compounds in honey) which has osteogenic effect in ovariectomized rats<sup>18</sup>. Daily consumption of 20 mg/day of tualang honey by postmenopausal women for four months produced a comparable results to the hormonal replacement therapy on bone density. Accordingly, tualang honey with its antioxidant and anti-inflammatory activities can be used as an alternative therapy for postmenopausal osteoporosis with minimal side effects<sup>28</sup>. Figure 3 shows the antioxidative and anti-inflammatory actions of tualang honey on bone<sup>28</sup>.

### 10- Hepatoprotective effect

Tualang honey supplementation in STZ-induced diabetic rats reduced elevated levels of AST, ALT and ALP. These data suggested that beside its antidiabetic and antioxidant effects, tualang honey also produced hepatoprotective effect in STZ-induced diabetic rats. In addition, it may be suggested that co-administration of tualang honey with other therapeutic agents may be effective in minimizing the side effects of synthetic drugs. The actual mechanisms by which tualang honey reduced elevated serum levels of liver enzymes in STZ-induced diabetic rats remain unclear<sup>29</sup>.

### 11- Cardioprotective effects

In an experimental study, tualang honey prevented the development of myocardial infarction induced by isoproterenol which appeared clearly by normal level of cardiac enzymes and normal histology of honey treated group in comparison to isoproterenol treated group. Furthermore, tualang honey improved levels of antioxidant enzymes levels in cardiac muscle and reduced lipid peroxidation. The cardioprotective effect of tualang honey against isoproterenol-induced oxidative stress is through its contribution to endogenous antioxidant enzymes via inhibition of lipid peroxidation<sup>30</sup>.

### 12- Renoprotective effect

In a recent study, tualang honey supplementation has resulted in an improvement of renal profile in rats fed on high cholesterol diet suggesting therefore its renoprotective effect against high cholesterol diet-induced acute kidney diseases. Additionally tualang honey showed improvement in LDL-c, TG and vLDL-c levels indicating its lipid lowering activities<sup>31</sup>.

## CONCLUSION

Tualang honey has antibacterial and antioxidants activities, antidiabetic activities, antiproliferative and antineoplastic activities and wound healing properties. It can improve learning and memory and restore osteoporotic bones. Tualang honey has beneficial effects on male and female reproductive systems. Furthermore, it has hepatoprotective, cardioprotective and renoprotective activities.

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