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The effect of acacia honey on hemorheological properties of blood: Preliminary reports

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Original article

Abstract

The effect of bee honey on the hemorheological properties of blood is an interesting issue from the perspective of natural medicine. A type of honey that enjoys great popularity in Poland is acacia honey, obtained from the nectar of *robinia pseudoacacia* (i.e. black locust). The aim of the study was to examine the effect of regular consumption of acacia honey for 2 weeks on the hemorheological properties of blood; hemorheology plays a key role in understanding physiological and pathological processes related to blood circulation. In the study, a group of women (n = 10) consumed 1 tablespoon of acacia honey daily for 2 weeks. Honey consumed regularly in moderate amounts (e.g., 1–2 teaspoons daily) can be a valuable addition to health-supporting diet. Fasting blood samples were collected from the participants at the beginning of the study and later after 2 weeks. After consuming acacia honey, statistically significant decrease was found in: MCH ($p < 0.05$), MCV ($p < 0.05$) and EI at shear stress 60.00 ($p < 0.05$). Statistically significant increase was found in: MPV ($p < 0.05$), PDW ($p < 0.05$). No significant changes were observed in other rheological parameters or glucose levels. This study is the first to report the effect of regular, short-term consumption of acacia honey on the hemorheological properties of blood, however, this topic still requires further research.

Keywords

- acacia honey
- hemorheology
- blood rheology

Contribution

A – Preparation of the research project
B – Assembly of data
C – Conducting of statistical analysis
D – Interpretation of results
E – Manuscript preparation
F – Literature review
G – Revising the manuscript

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Introduction

The use of bee honey is helpful in the prevention of various ailments, as well as in the treatment of chronic diseases.[1] The health-promoting properties of honey are influenced by its composition, which makes it beneficial for gastrointestinal, respiratory, urinary, and nervous system disorders.[2-6] One of the most popular types of honey in Poland is acacia honey, obtained from the nectar of *robinia pseudoacacia* (i.e. black locust) flowers, the plant also known as false acacia or white locust, which provides nectar for bees in May and June. It has a beautiful color resembling straw and sweet taste. Higher amount of fructose compared to glucose keeps the honey in liquid state for a long time (from several months to a year). Acacia honey is first colorless, and only after crystallization turns white or creamy yellow. Its aroma resembles acacia flowers, and its taste is delicate and particularly sweet. Acacia honey also contains flavonoids (robinin and acacetin), essential oils, syringic acid, and small amounts of trace elements. Characteristic volatile compounds include benzaldehyde and cis-linalool oxide.[7] Among the phenolic compounds (46 mg/kg), the following were detected: chrysin (56%), galangin (17%), and quercetin (11%), with smaller amounts of kaempferol, apigenin, and luteolin.[7] Acacia honey has low protein content (86 mg/kg) and low levels of free amino acids, with proline being dominant (546 mg/kg), which makes it beneficial for urinary tract diseases.[7] Acacia honey exhibits also mild antibiotic and antiinflammatory effects. It is recommended for gastrointestinal diseases: indigestion, gastrointestinal spasms, gastritis and enterocolitis, and oversecretion of gastric juice. It is used as a supportive treatment for gastric and duodenal ulcers, as it accelerates the regeneration of the mucous membrane, improves motility, increases mucus secretion, and enhances granulation.[7,8] Acacia honey is also used in the treatment of common cold-related illnesses, especially those involving inflammation of the upper respiratory tract, due to its antiinflammatory, antimicrobial, and anticancer properties. [9,10] Some data indicate exceptional antibiotic activity of acacia honey against Gram-positive bacteria, including staphylococci and streptococci. It is also recommended for coughs, preferably dissolved in an infusion of wild mallow flowers in the ratio of 50 g of honey to 250 ml of infusion.[7] Due to its low glycemic index (GI < 55), resulting in part from its high fructose content, acacia honey can be used by persons with type 2 diabetes.[7] It is also valued as a supportive agent for kidney, urinary tract, and prostate function, as well as in kidney stones, due to its exceptionally low content of trace elements and amino acids, and its antimicrobial, antiinflammatory, diuretic, and antispasmodic properties.[7,11,12] The calming and generally strengthening effects of acacia honey may be beneficial in cases of insomnia, as well as symptoms of fatigue, tiredness, and exhaustion. Thanks to the contents of simple sugars, which are easily and quickly absorbed by the body, it serves as a valuable regenerative nutrient in cases of physical and mental fatigue.[7]

An increasing body of evidence indicates that hemorheological properties of blood are one of the fundamental determinants of proper tissue perfusion from hemorheological perspective.[13,14] Blood rheology refers to the flow properties of blood, which are determined, among other factors, by blood viscosity, the elasticity of erythrocytes, and their ability to aggregate and their deformability. From hemorheological standpoint, the deformability of erythrocytes—i.e., the ability of red blood cells to change shape while passing through blood vessels—is of particular importance.[15] This property affects the efficiency of microcirculation and oxygen transport. Changes in erythrocyte deformability may indicate adaptive responses of the body to stimuli. Deformability of erythrocytes, may depend, among other things, on the condition of the cell membrane, hemoglobin concentration, and the properties of the cytoplasm.[14] Red blood cell aggregation is a process in which these cells reversibly bind together to form rouleaux. Numerous factors influence the level of aggregation: temperature, pH, osmolarity, plasma protein composition, and oxidative stress.[14] Under physiological conditions, aggregation plays a role in regulating blood viscosity, but excessive aggregation can lead to microcirculatory disorders, increased risk of thrombosis, and tissue hypoxia.

The aim of this study is to examine the effect of regular consumption of acacia honey on the hemorheological properties of blood over a two-week period. Hemorheology plays a key role in understanding physiological and pathological processes related to blood circulation. Disturbances in these parameters can lead to microcirculation problems, hypertension, thrombosis, or cardiovascular diseases.

Patients and methods

Patients

The study included 10 female patients, healthy individuals aged from 41 to 60 years , with body mass of 53–73 kg, and height of 159–171 cm, who were included in the research program after obtaining doctor's consent. The participants were free of any chronic diseases including diabetes, heart diseases, metabolic disorders, endocrine disorders. Smoking, active infections, and neoplasms constituted further exclusion criteria. The participants, fully acquainted with the study details, provided their written consent to take part in the experiment. All the applied procedures followed the Declaration of Helsinki with its amendments.

Methods

An experimental group of women (n = 10) consumed one tablespoon of acacia honey daily over a two-week period. When consumed regularly in moderate amounts (e.g., 1–2 teaspoons per day), honey can serve as a valuable dietary supplement supporting overall health. The acacia honey used in the study was sourced from a local apiary located in the Radgoszcz region of the Lesser Poland Voivodeship. The apiary is owned by Leszek Sołtys (Apiary address: ul. Szczucińska 12, 33-207 Radgoszcz, Apiary ID: WIN 12045612) (Fig. 1).

Figure 1. Honey from the apiary of Leszek Sołtys

Fasting blood samples (10 ml) were collected from the ulnar vein of each participant both before and after the honey supplementation period. lood was drawn at the Blood Physiology Laboratory of the Central Research and Development Laboratory at the University of Physical Culture in Kraków, Poland. Samples were collected into Vacuette EDTA K2 tubes and clot activator tubes. The following parameters were assessed on the day of collection: morphological, hemorheological, and glucose-related blood parameters. Analyses were conducted at the aforementioned university laboratory and at Diagnostyka S.A., a certified medical diagnostics laboratory in Kraków, Poland.

Morphological analyses

The following blood count parameters were assessed: RBC – red blood cell count [$10^6/mm^3$]; HGB – hemoglobin [g/dL]; HCT – hematocrit [%]; MCV – mean corpuscular volume [μm^3]; MCH – mean corpuscular hemoglobin [pg]; MCHC – mean corpuscular hemoglobin concentration [g/dL]; RDW – red blood cell distribution width [%]; WBC – white blood cell count [$10^3/mm^3$]; NEUT – neutrophils [$10^3/mm^3$]; LYMPH – lymphocytes [$10^3/mm^3$]; MONO – monocytes [$10^3/mm^3$]; EOS – eosinophils [$10^3/mm^3$]; BASO – basophils [$10^3/mm^3$]; PLT – platelet count [$10^3/mm^3$]; MPV – mean platelet volume [μm^3]; PDW – platelet distribution width [%] Measurements were performed using the ABX Micros 60 hematology analyzer (HORIBA ABX SAS, Montpellier, France).

Rheological assessments

Blood rheology parameters were measured using the Laser-Assisted Optical Rotational Red Cell Analyzer (LORRCA) (MaxSis Lorrca®, RR Mechatronics, The Netherlands), following the method described by Hardeman.[16] The following parameters were measured: Aggregation Index (AI) [%]; Amplitude and total extent of aggregation (AMP) [arbitrary units]; Half-time of total aggregation (T½) [s]; Erythrocyte deformability (Elongation Index, EI); mean EI values were determined at shear stress levels of 0.30, 0.58, 1.13, 2.19, 4.24, 8.23, 15.95, 30.94, and 60.00 Pa using the automatic analysis function of the LORRCA system, which evaluates erythrocyte deformability and aggregation as a function of shear stress.

Fibrinogen determinations (in units [g/l]) were performed using CHROM-7 coagulometer (Poland). Plasma viscosity (PV) [mPas] was assessed using the

DVNext Brookfield Ametek Cone/Plate Rheometer (Brookfield, Middleboro, MA, USA). The device uses a calibrated beryllium-copper spring to measure torque generated by the resistance of the plasma sample between a rotating cone and a stationary plate. Measurements were conducted at 37°C using CP-40Z spindle at shear rate of 450 s^{-1}.

The following blood biochemical indices were measured in plasma by using biochemical analyzer Roche/Hitachi Cobas c 501, module 600: glucose [mmol/L].

Results

To assess statistical differences between baseline and post-intervention values following acacia honey consumption, paired Student's t-test was applied. The level of statistical significance was set at $\alpha = 0.05$. The results of the analysis are presented in Tables 1–4.

Following the two-week acacia honey intake, significant reductions were observed in the mean corpuscular hemoglobin (MCH) and mean corpuscular volume (MCV) ($p < 0.05$), as well as in the erythrocyte elongation index (EI) at shear stress of 60.00 Pa ($p < 0.05$). In contrast, significant increases were noted in mean platelet volume (MPV) and platelet distribution width (PDW) ($p < 0.05$) (see Tables 1–2). No statistically significant changes were observed in other hemorheological parameters or blood glucose levels.

Discussion

The analysis of hemorheological, morphological, and glucose-related blood parameters in female participants following short-term consumption of acacia honey provides valuable insights into the physiological responses to this dietary intervention, while most parameters remained unchanged.

Table 1. Mean values (± standard deviation) of the morphological parameters before and after consumption of honey

Parameter	Baseline (n = 10) (mean values ± SD)	After consumption of honey (mean values ± SD)	*t*	*p*
RBC [106/mm3]	4.43 ± 0.34	4.45 ± 0.35	–0.39	0.705
HGB [g/dL]	13.33 ± 0.95	13.26 ± 0.94	0.44	0.671
HCT [%]	38.33 ± 2.56	38.01 ± 2.87	0.61	0.558
MCH [pg]	30.13 ± 0.49	29.85 ± 0.53	2.91	**<0.05***
MCHC [g/dL]	34.77 ± 0.72	34.90 ± 1.10	–0.52	0.615
MCV [μm3]	86.66 ± 2.55	85.53 ± 2.50	2.76	**<0.05***
RDW [%]	39.08 ± 2.55	38.43 ± 2.29	2.05	0.071
WBC [103/mm3]	4.97 ± 1.14	4.74 ± 1.41	0.93	0.375
NEUT [103/mm3]	2.62 ± 0.86	2.62 ± 0.83	0.03	0.976
LIMF [103/mm3]	1.71 ± 0.32	1.54 ± 0.51	1.74	0.117
MON [103/mm3]	0.43 ± 0.12	0.40 ± 0.15	1.83	0.101
EOS [103/mm3]	0.17 ± 0.12	0.14 ± 0.13	1.42	0.188
BASO [103/mm3]	0.04 ± 0.02	0.04 ± 0.03	–0.36	0.726
PLT [103/mm3]	227.20 ± 40.58	214.53 ± 86.06	0.62	0.550
MPV [μm3]	10.55 ± 0.91	11.02 ± 0.88	–2.94	**<0.05***
PDW [%]	12.50 ± 1.79	13.16 ± 1.86	–2.34	**<0.05***

Note: $^{*}p < 0.05$.

Table 2. Mean values (± standard deviation) of the elongation index before and after consumption of honey

Parameter	Baseline (n = 10) (mean values ± SD)	After consumption of honey (mean values ± SD)	*t*	*p*
EI at 0.30 Pa	0.04 ± 0.01	0.05 ± 0.01	−1.96	0.081
EI at 0.58 Pa	0.10 ± 0.01	0.11 ± 0.02	−0.36	0.726
EI at 1.13 Pa	0.23 ± 0.01	0.23 ± 0.02	0.00	1.000
EI at 2.19 Pa	0.34 ± 0.01	0.34 ± 0.02	1.00	0.343
EI at 4.24 Pa	0.45 ± 0.01	0.45 ± 0.01	1.50	0.168
EI at 8.23 Pa	0.52 ± 0.01	0.52 ± 0.01	−0.56	0.591
EI at 15.59 Pa	0.57 ± 0.01	0.57 ± 0.01	−0.56	0.591
EI at 30.94 Pa	0.61 ± 0.01	0.61 ± 0.01	1.96	0.081
EI at 60.00 Pa	0.649 ± 0.00	0.644 ± 0.01	3.00	**<0.05***

Note: $^{*}p < 0.05$.

Table 3. Mean values (± standard deviation) of erythrocyte aggregation parameters before and after consumption of honey

Parameter	Baseline (n = 10) (mean values ± SD)	After consumption of honey (mean values ± SD)	*t*	*p*
AMP [au]	38.72 ± 4.11	36.38 ± 3.36	1.52	0.163
T1/2 [s]	3.33 ± 1.47	2.73 ± 1.03	1.27	0.237
AI [%]	56.60 ± 10.11	60.64 ± 8.72	−1.27	0.237

Note: $^{*}p < 0.05$.

Table 4. Mean values (± standard deviation) of glucose, plasma viscosity, and fibrinogen levels before and after consumption of honey

Parameter	Baseline (n = 10) (mean values ± SD)	After consumption of honey (mean values ± SD)	*t*	*p*
Plasma viscosity [mPa]	1.47 ± 0.12	1.47 ± 0.09	−0.11	0.913
Fibrinogen [g/L]	3.32 ± 0.53	3.51 ± 0.42	−1.16	0.277
Glucose [mmol/l]	4.80 ± 0.31	4.95 ± 0.31	−2.02	0.074

Note: $^{*}p < 0.05$.

In the study the short-term intake of acacia honey resulted in significant reduction in mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and erythrocyte deformability (EI) at shear stress of 60.00 Pa. Conversely, there was significant increase in mean platelet volume (MPV) and platelet distribution width (PDW). No significant changes were found in other hemorheological parameters or in blood glucose levels, which is likely due to the relatively short duration of acacia honey consumption. Acacia honey contains a variety of bioactive compounds, including vitamins (C, E, B6), minerals (iron, magnesium, calcium), antioxidants, enzymes (e.g., amylase, glucosidase), and organic acids (e.g., gluconic acid). These components may influence blood rheology, particularly through their effects on red blood cells, which are key determinants of hemorheological properties. Although acacia honey contains trace amounts of iron—essential for hemoglobin synthesis—its impact on hemoglobin levels and red blood cell indices is limited compared to iron-rich foods such as meat. However, when consumed as part of an iron-rich diet, acacia honey may support hematopoietic system. The sugars in honey, primarily glucose and fructose, can affect the body's osmotic balance and nutrient absorption, including iron, which is critical for erythrocyte function. Iron deficiency may lead to microcytic anemia, characterized by reduced MCV and MCH, and impaired red blood cell deformability under high shear stress. The observed reductions in MCV, MCH, and EI at 60.00 Pa may also reflect an adaptive response to changes in blood glucose metabolism. Thanks to antioxidants (particularly flavonoids) present on honey, it may help protect erythrocytes from oxidative stress—a condition associated with excess free radicals that can damage cell membranes and impair deformability. The antiinflammatory and antioxidant properties of honey may enhance red blood cell flexibility and protect against aggregation and oxidative stress. While honey's antioxidant effects may benefit vascular health, its consumption in larger quantities could potentially increase platelet aggregation. Elevated platelet activity may lead to increased platelet volume and variability in size distribution, as reflected by higher MPV and PDW values, which we have confirmed in our previous research. These changes may represent physiological response to altered glucose metabolism and effects of honey on cardiovascular system. It is worth noting that acacia honey has relatively low glycemic index (GI ~35–50), and therefore it elevates blood glucose levels more slowly than other sugars such as glucose or sucrose.

In conclusion, this study is the first to report the impact of regular, short-term acacia honey consumption on blood hemorheological properties, however, further research in this area is necessary.

Conclusions

1. The observed decreases in MCV, MCH, and elongation index at 60.00 Pa may represent an adaptive response of the body to changes in blood glucose levels following short-term consumption of acacia honey. These changes may also be related to iron deficiency in the diet or impaired iron absorption.
2. Short-term consumption of acacia honey may influence the cardiovascular system, particularly by increasing platelet activity, which is reflected in elevated MPV and PDW values.
3. The short-term use of acacia honey for health purposes should be moderate to avoid potential side effects associated with excessive sugar intake.
4. The effect of consumption of acacia honey on blood hemorheological properties has not been directly confirmed in clinical studies and requires further investigation.

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