Evaluation of Blood Glucose-regulating Potential of Honey, Coffee and Vitamin E in Normoglycaemic Male Wistar Rats

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Original Research Article

ABSTRACT

This research studied the effect of honey, coffee and vitamin E on blood glucose level in non-diabetic experimental design. A total of 30 Wistar rats weighing 200-220 grams were used. The experimental period lasted for 56 days. Blood glucose test was carried out on days 0, 18, 37 and 56. Data derived from the experiment was presented after mean comparisons and percentage change evaluation. The result showed that honey and honey co-administered coffee or vitamin E time-dependently reduced blood glucose level significantly. Vitamin E alone did not have any significant effect on blood glucose, but coffee alone time-dependently increased blood glucose level significantly. From this study, honey may be effective in regulating blood glucose level, vitamin E, except co-administered honey, has no significant effect on blood glucose and coffee alone may cause a significant increase in blood glucose level, except if it is co-administered honey.

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1. INTRODUCTION

Honey is consumed by many nationalities due to its sweet taste [1]. Some believe honey is a therapeutic agent in reducing stress [3,4], others believe a spoon of honey may help relieve or prevent cardiac illness [1,4] and erectile dysfunction [7]. Despite all these, the sweetness of honey has made it somewhat controversial in relation to blood glucose regulation [5,10]. Not only honey but also coffee, a common beverage [11,16] and vitamin E, an antioxidant [11], are good candidates that possess controversial blood glucose regulating effect [11,12]. Some reports have revealed the hyperglycemic potential of coffee [11] and a negatively correlating effect on blood glucose after several doses of vitamin E [11]. The outcome of other studies reveals that coffee may affect blood glucose either positively or negatively. More reports have reported an insignificant change in relation to vitamin E administration [11,23]. This study aimed to determine the effect of honey, coffee and vitamin E on fasting blood glucose in normal Wistar rats.

2. MATERIALS AND METHODS

2.1 Purchase of Treatment Agents

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Fresh honey was purchased from University of Port Harcourt food and drugs facility, the brand was 'Divine Honey'. The purity of the honey was authenticated in the laboratory for Microbiological Sciences, Department of Microbiology, Faculty of Natural Sciences, and the University of Port Harcourt. The honey was unprocessed, pure and of good quality; did not attract ants, did not completely freeze, crystallises and burns when cotton bud dipped into it is passed over a flame. Coffee was purchased from an online retail outlet. Vitamin E was purchased from Ebus Pharmacy in Port Harcourt.

2.2 Experimental Animals and Protocols

Thirty (30) adult male Wistar rats weighing 200 to 220 grams were obtained from the Experimental animal unit, Department of Human Physiology, University of Port Harcourt. Using the standard protocols [26], all experimental animals were properly screened and confirmed by a Veterinarian in the institution to be physically healthy. With the simple random technique of sampling, the animals were divided into four (6) groups containing six (5) rats per group. The animals were allowed to acclimatise for two weeks before the start of the experiment which lasted for 56 days. All animals had access to food and water *ad libitium*. The cages were properly cleaned twice daily to avoid coprophagy.

2.3 Study Design

Groups	Treatments	Dose of treatment
1	feed and distilled water	*Ad libitium*
2	Vitamin E	0.15 ml
3	Honey	2 ml
4	Coffee	1.6 ml
5	Honey + Coffee	2 ml+1.6 ml
6	Honey + Vitamin E	0.15 ml+1.6 ml

The normal rat feed from Anifeed® industries, containing carbohydrate, proteins and fat, in a balanced ratio, was used as feed throughout this research.

2.4 Treatment Method

All treatment agents were administered via the orogastric route following standard laboratory procedures [10].

2.5 Collection of Blood Samples

Blood was collected four (4) times in four (4) different days of equal interval. The collection of blood samples include;

Days	Experimental periods
0	before the onset of administration of treatment agents
18	18th day after onset of administration of treatment agents
37	37th day after onset of administration of treatment agents
56	56th day after onset of administration of treatment agents

2.6 Blood Glucose Test

Blood glucose test was carried out using a Finetest® glucometer purchased from Technomed® Plaza in Borokiri, Port Harcourt. The corresponding test strips were used. The

method was based on the biochemical principle of enzyme catalysis [27]. Whereby, glucose oxidase enzyme catalyses the oxidation of glucose to gluconic acid and hydrogen peroxide which can be detected by a change in absorbance of the test sample. The animals were subjected to fast for about 12 hours before collection of blood samples.

2.7 Ethical Approval

This study was approved by the Madonna University Research Ethics Committee and Research Ethics Committee of the Department of Human Physiology, University of Port Harcourt. All experimental procedures were done strictly following the guidelines provided by the research ethics committee. The animals were sacrificed after exposure to diethyl ether according to EC directives 86/609/EEC. In addition, the laid down standards according to the 1964 declaration of Helsinki were strictly adhered to. All animals were handled with care and experimental procedures that reduce, refine or replace suffering of the animals were adopted.

2.8 Statistical Analysis

Experimental data are presented in Mean ± Standard error of the mean (SEM). Percentage (%) change was also calculated to make the data well translated. SPSS 20.0 was used for all calculations and statistical analysis such as One-way analysis of variance (ANOVA). Values are significant at $p \leq 0.05$ or at a confidence interval of 95%.

3. RESULTS

From Table 1;

Vitamin E treated groups had a non-significant change in blood glucose from day 0 at 4.30±0.095 to day 18 (4.34±0.095), day 37 (4.32±0.095) to day 56 (4.38±0.095). The percentage change was 0.93, -0.4 and 1.38 for day 0 to 18, 18-37 and 37 to 56 respectively. Honey treated group had a significant decrease in blood glucose from day 0 at 4.52±0.095 to day 37 (3.72 ± 0.095^{a0}) with a percentage change of -7.1 to day 56 (3.08 ± 0.095^{a0}) with a percentage change of -17 from day 37. Coffee treated group had a significant increase in blood glucose from day 0 at 4.28±0.095 to 37 (4.76 ± 0.095^{0}) also further increased to 5.58 ± 0.095^{a0} on day 56. The percentage change from day 0 to day 37 was 2.1; from day 37 to day 56 was 17.2. The coffee group had the highest percentage positive change in blood glucose compared to other treatment groups. The group co-administered honey and coffee had a time-dependent change in blood glucose. The change in blood glucose was not significant from day 0 (4.38±0.095) to day 18(4.64±0.095) percentage change of 5.9 and day 37 (4.14±0.095) percentage change of -12.0 from day 18. The blood glucose decreased significantly on day 56 (3.50 ± 0.105^{a0}) with a percentage change of -15.4 from day 37. The group co-administered honey and vitamin E had a time-dependent change in blood glucose. The change in blood glucose was not significant from day 0 (4.54±0.095) to day 18(4.36±0.095) percentage change of -4.1 but blood glucose significantly decreased from day 37 (3.66 ± 0.095^{a0}) percentage change of -16 from day 18. The blood glucose further decreased significantly on day 56 (3.10 ± 0.095^{a0}) with a percentage change of -15.3 from day 37.

From Table 2;

The percentage change relating each blood glucose test day to day 0 was presented. The highest percentage decrease was in honey-treated groups, from day 0 to day 56 at -32%.

Table 1. Effect of honey, coffee and vitamin E on blood glucose

Treatments	Blood glucose						
	(mmol/L)	%	(mmol/L)	%	(mmol/L)	%	(mmol/L)
	Day 0	0-18	Day 18	18-37	Day 37	37-56	Day 56
Control	4.42±0.095	1.80	4.50±0.095	-1.7	4.42±0.095	0.45	4.44±0.095
Vit E	4.30±0.095	0.93	4.34±0.095	-0.4	4.32±0.095	1.38	4.38±0.095
Honey	4.52±0.095	-7.1	4.20±0.095	-11.4	3.72 ± 0.095^{a0}	-17	3.08 ± 0.095^{a0}
Coffee	4.28±0.095	8.8	4.66±0.095	2.1	4.76 ± 0.095^{0}	17.2	5.58 ± 0.095^{a0}
Honey+Coff	4.38±0.095	5.9	4.64±0.095	-12.0	4.14±0.095	-15.4	3.50 ± 0.105^{a0}
Honey+Vit E	4.54±0.095	-4.1	4.36±0.095	-16	3.66 ± 0.095^{a0}	-15.3	3.10 ± 0.095^{a0}

N=5

[a] p<0.05was considered significant compared with control on the same day

[0] p<0.05was considered significant compared with day 0 of the same treatment

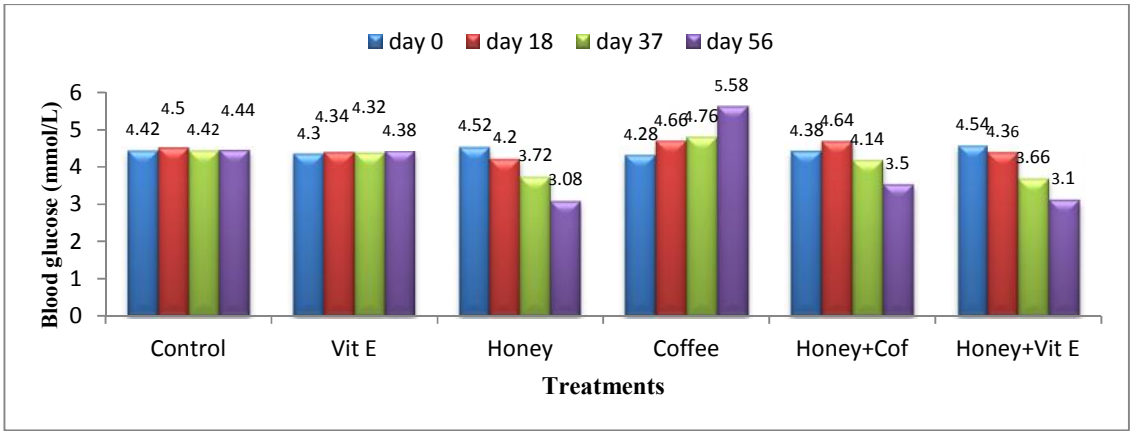

Fig. 1. Effect of honey, coffee and vitamin E on blood glucose

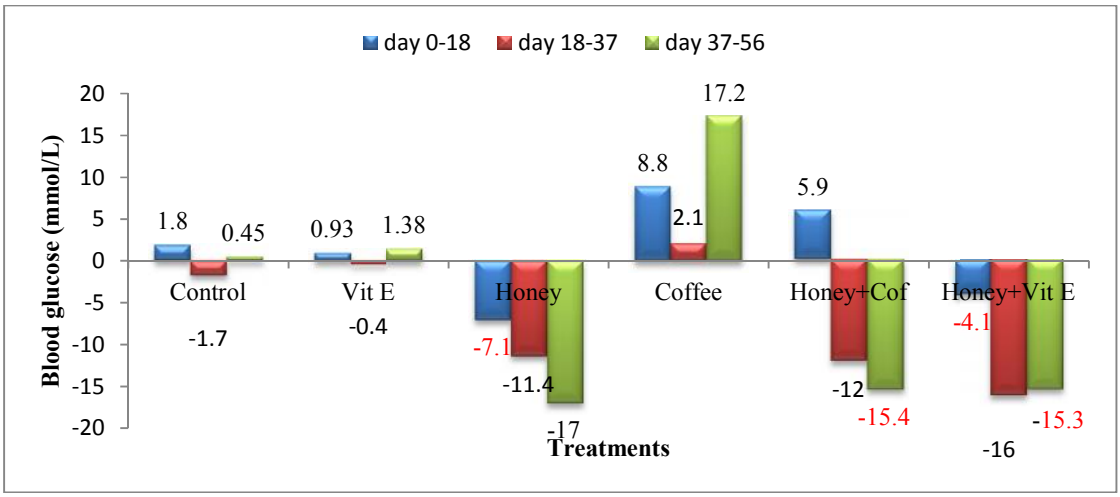

Fig. 2. Effect of honey, coffee and vitamin E on blood glucose using % change

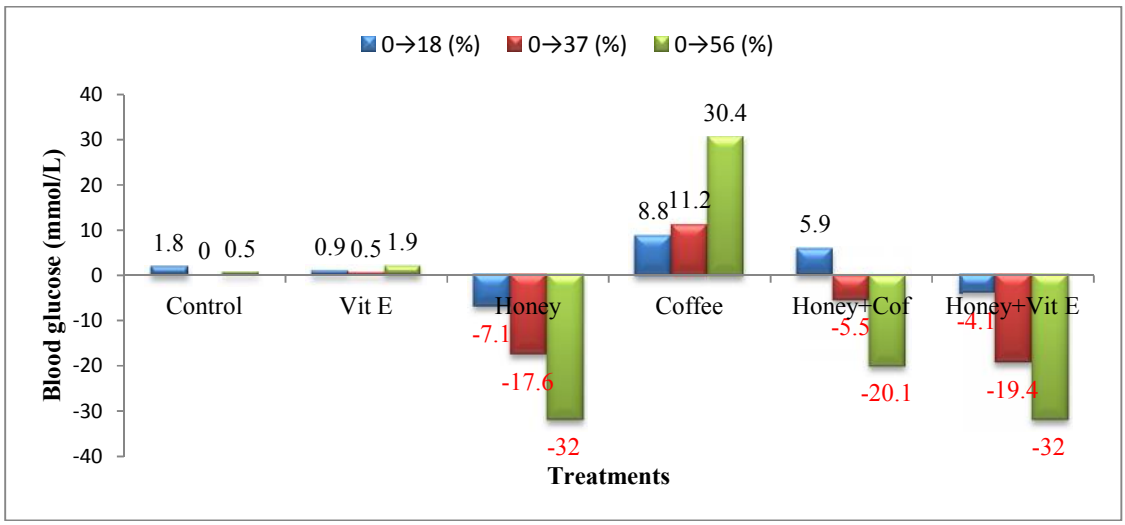

Fig. 3. Effect of honey, coffee and vitamin E on blood glucose using % change n relation to day 0

Table 2. Percentage relative effect of honey, coffee and vitamin E on blood glucose

Treatments	0→18 (%)	0→37 (%)	0→56 (%)
Control	1.8	0	0.5
Vit E	0.9	0.5	1.9
Honey	-7.1	-17.6	-32
Coffee	8.8	11.2	30.4
Honey+Cof	5.9	-5.5	-20.1
Honey+Vit E	-4.1	-19.4	-32

Negative sign indicates a percentage (%) decrease. All values are relative to day 0.

The group co-administered honey and coffee had its highest percentage decrease in blood glucose from day 0 to day 56 at -20.1. The group co-administered honey and vitamin E had the highest percentage decrease in blood glucose from day 0 to day 56 at -32. In all 3 of the aforementioned groups, it was well translated that the decrease in blood glucose was time-dependent. Coffee treated groups presented the highest time-dependent increase in blood glucose compared to all treatments. This increase in blood glucose was highest from day 0 to day 36 at 30.4.

4. DISCUSSION

The active biochemical components of honey may probably be responsible for its blood glucose lowering effect [7,14]. Honey has an abundance of micro-minerals [1] most of which serve as important components in insulin signalling [5] and sensitivity [2]. Some constituents like fructose and palatinose enhance or activate insulin response system [9], captivation of cellular glucose [3] and delay of digestion and absorption of starch [4]. One major cause of glucose intolerance is pro-oxidative changes [10]. Pro-oxidation may be induced by physiologic changes like post-prandial hyperglycemia [11,16,18]. Honey, in this study, may have the potency of regulating post-prandial blood glucose surge. At the studied dose, honey can thus be said to the effect in regulating blood glucose level under normal conditions; this is in agreement with earlier reports [15]. Coffee due to its caffeine content [11,17] may probably have altered the plasma level of cathecolamines[11], cortisol [11,19] and growth hormones[11]. These diabetogenic factors may be the stimuli behind the glucose increase in coffee treated groups. This is in correspondence with earlier reports [11]. Caffeine in coffee increases the synthesis of energy currencies like adenosine triphosphate (ATP) [14] through oxidative phosphorylation. Adenosine triphosphate (ATP) is an allosteric inhibitor of glycolysis at the level of phosphofructokinase [30]. This allosteric inhibition causes glycolysis to be 'tuned-off', followed by a prolonged increase in blood glucose. Vitamin E effect on blood glucose has caused much controversy [21,23]. The majority of studies have pointed at either an indirect effect as a result of its antioxidant function [11,26,27]. If this is the case, then oxidative stress may be the reason behind the increase in blood glucose [24] of coffee treated groups in this study and vitamin E treatment maintained blood glucose level within a given range due to its antioxidant function. The direct effect of vitamin E in this study may be its role as a coenzyme or protector of enzyme systems during glucose homeostasis. This is in agreement with earlier reports [11,24]. The group co-administered honey and coffee had a time-dependent decrease in blood glucose compared to the effect of coffee alone which may be due to the synergy between the glucose-regulating components in honey like phenolic acids, kaempherol, fibres, chromium and magnesium, and the bioactive glucose-lowering agent in coffee called Chlorogenic acids [11,16]. Co-administration of honey and vitamin E in this study revealed a time-dependent increase in blood glucose. This is a good example of blood glucose regulation caused by organic biomolecules, inorganic biomolecules and antioxidant systems, all acting in synergy.

5. CONCLUSION

From the outcome of this study, honey may be consumed for a prolonged period if a desire to reduce blood glucose is to be achieved. Effect of Vitamin E on blood glucose for the particular treatment dose and for the time frame of this study was not significant. Coffee should not be advised as a beverage of choice for pre-diabetics or diabetics but may be beneficial in hypoglycemic conditions. If coffee is coadministered honey or vitamin E, due to the synergistic effect of the constituents of both treatment agents, coffee may possess blood glucose-lowering effect. This means some constituents in coffee may have the ability to reduce blood glucose if only their action is potentiated by the constituents of another treatment agent. Co-administration of coffee and honey, as well as honey and vitamin E, may be of benefit in blood glucose regulation.

6. RECOMMENDATON

Further research on diabetes-induced experimental model is recommended.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

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All thanks to God, the alpha and the omega, the beginning and the end, and the only door way to success.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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