

# A PRELIMINARY COMPARATIVE STUDY ON THE EFFECTS OF HONEY AND SOME REFINED CARBOHYDRATES ON RATS

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## ABSTRACT

*The effects produced by diets containing refined sugars, sucrose, glucose and fructose on albino rats were investigated in comparison to a honey-containing diet. The feeding regimen was started with weanlings, and was continued to the eleventh week. The refined sugars were found to elevate the levels of blood glucose, cholesterol and total serum lipids. Rats on the sucrose diet had the highest mean blood glucose of  $6.77 \pm 0.13$  mmol/litre which was statistically different (student's *t*-test at  $p < 0.05$ ) from all the other diets. On the other hand, the honey diet gave a blood glucose level of  $5.89 \pm 0.35$ , and this was significantly lower than those of the refined sugars. It was the sucrose that gave the highest mean serum cholesterol and total lipids of  $140.11 \pm 3.42$  and  $230.12 \pm 2.67$  mg/dl respectively. Honey, on the other hand did not cause much elevation. Results of this work, thus portray the advantage honey may have as a sweetener as compared to the refined sugars.*

**KEYWORDS:** Sweetener, triacylglycerols, cholesterol, lipogenic, metabolism.

## INTRODUCTION

There is a positive correlation between high levels of blood lipids and some degenerative diseases as exemplified by the elevated levels of blood cholesterol and triacylglycerols posing as some major risk factors to coronary heart diseases [1,2,3].

Several dietary components, especially, the lipids and carbohydrates contribute to the elevation of blood lipid levels. The dietary carbohydrates are known to affect these blood lipid levels, both in the short term [14] and long term [5].

The lipogenic nature of the various carbohydrates is not the same with the refined carbohydrates being more lipogenic than the complex ones. Several reports [6,7,8]

indicate that the chronic consumption of sucrose leads to increased blood triacylglycerol and cholesterol levels. Fructose and sucrose have also been shown to cause greater weight increase in rats than starch [9].

Another problem posed by the carbohydrates in the diet is the high levels of blood simple sugars that some produce. Such high levels of blood simple sugars in the blood could cause the non-enzymatic glycosylation of some proteins, the outcome of which could be the alteration of the metabolism and functions of some proteins [17,27]. In diabetes mellitus, it has been proposed that glycosylation of some tissue proteins is a contributory factor to some of the complications of the disease [17,27].

The high lipogenicity of the refined carbohydrates requires that they are replaced by compounds which are less harmful. So in this work, the searchlight is being thrown on honey, a natural sweetener.

Honey is a sweet viscid liquid from the nectars of flowers, processed through the activities of bees. It contains a wide range of compounds including sugars, organic acids, amino acids, pigments and gums [10]. Other components are vitamins (A, B complex and C) as well as mineral ions. Predominantly, it is made up of carbohydrates - these constitute 82.3% [11]. Smith [12] had reported that honey contained 41% fructose, 35% glucose, together with other components.

One common use of honey is as a sweetener. But there are evidences available [13,14,15] on its use as a medicament in the treatment of wounds. The wound-healing effect has been attributed to the lowering of pH and water activity effects which change the ecology of the wound [15] to prevent the growth of common pathogenic microbes [14].

In this country the government of the first Republic started beekeeping development through the Ministry of Agriculture in the early part of the sixties, but this could not be sustained until it was revitalised in 1978 by the Technology Consultancy Centre (TEC) [30]. With the support of the TCC, bee-keeping, and honey production have been on the increase in various parts of the country, especially, the Brong Ahafo, Volta, Northern and Central regions, but the actual production figures of honey in the country are not known (Personal Communications). What is rather obvious is that consumption of honey in the country outstrips production. Locally it used as sugar substitute, as food for children, and as a sweetener for diabetics (Personal Communications).



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Even though the use of honey as sweetener is commonplace, not much is known about its effect on blood lipids, therefore, our work was set out to investigate this.

## MATERIALS AND METHODS

Five groups of albino rats, each group made up of four were used. These experimental animals were weanlings about two weeks old. Each animal, was kept in a separate cage, and given food and water *ad libitum*. The composition of the diet for four groups is shown in Table 1.

At the end of the eleventh week blood was drawn from the animals through cardiac puncture after the animals had been starved overnight, and undergone sodium pentobarbital anaesthesia.

The blood glucose was determined by the o-toluidine method, cholesterol by a method based on the Liebermann-Buchard reaction, and the total serum lipids by the phosphovanillin method.

Table 1: The Composition of the Diet for Four groups of Rats.

Component	Percentage (%)
*Sugar	10
Maize	60
Casein	10
Fibre	8
Lipid	10
Vitamin-Mineral mix	2

\*The sugar component was varied in the four groups. In the case of the fifth group, the control, they were given commercial poultry feed. ("Frytol" cooking oil, a product of Lever Brothers, Ghana Ltd. was the lipid source. 'Nutrivet', made by Werft-Chemie, Austria, contained oxytetracycline, the vitamins, trace elements and amino acids in a carrier of dry mycelium). The honey used was purchased from the Kumasi Central market, and it was a product from Brong Ahafo Region.

## RESULTS

The type of carbohydrate had an effect on the fasting blood glucose levels. Rats on the sucrose diet had the highest mean blood glucose. This was statistically different (Student's t-test at  $p < 0.5$ ) from all the other diets. In comparison with the refined sugars, the honey-containing diet gave a significantly lower blood glucose level. There was no significant difference between the blood glucose levels of the rats given fructose and glucose diets.

## Blood lipids (Table 2)

The highest mean serum cholesterol and total lipids were produced by the sucrose diet. On the other hand, the control diet gave the lowest blood lipid levels. For the test diets, the honey gave the lowest lipid levels which were significantly different ( $p < 0.05$ ) from the other sugars.

Table 2: Mean Blood Glucose, Cholesterol and Serum Total Lipids in the Rats on the Various Diet

Type of Diet	Mean Blood Glucose (mmol/litre)	Mean Serum Cholesterol (mg/dl)	Mean Total Serum Lipids (mg/dl)
Glucose	6.42 ± 0.22	118.00 ± 4.20	198.80 ± 3.93
Fructose	6.31 ± 0.20	128.00 ± 3.20	204.22 ± 3.56
Sucrose	6.77 ± 0.13	140.11 ± 3.42	230.12 ± 2.67
Honey	5.89 ± 0.35	100.55 ± 3.12	172.89 ± 3.13
Control	4.01 ± 0.65	91.76 ± 4.12	163.25 ± 2.60

Mean ± Standard Deviation

## DISCUSSION

The refined carbohydrates, sucrose, fructose and glucose gave the highest level of fasting blood glucose. Park et al [29] had made a similar observation in a study in which rats fed on purified carbohydrates were found to have a raised fasting blood glucose as a consequence of the increased action of the catabolic hormones which stimulated lipolysis and proteolysis, providing the necessary precursors for glucose production. In another study [16] using sucrose, this sugar was found to stimulate the formation of glucose-6-phosphatase.

Since the glucose level in the rats given the honey-containing diet was intermediate between the control and the refined sugars, it can be said that the fructose and glucose in the honey could potentially raise the blood sugar level, but at the same time, the honey may contain some components which could modulate the activities of some gluconeogenic enzymes and/or hormones. However, one could be tempted to say that the modulatory effect being proposed appears less prominent by the fact that the percentage of sugar in the honey is a little lower than the refined sugars. According to Muller [12], the percentage carbohydrate in honey is 82.3. This means that the 10% honey used in our dietary formulation should be equivalent to 8.23% carbohydrate. This difference is not much so we stick to the modulatory hypothesis.

## Cholesterol and Total Serum Lipids

The total serum lipids are made up of mainly cholesterol, triacylglycerol and phospholipids. Thus the

difference between the total serum lipids and cholesterol, should give the triacylglycerols and phospholipids.

That the sucrose- and fructose-containing diets gave the highest blood lipid levels is in agreement with the other reports [18,22]. Fructose has been shown to be more lipogenic than glucose because the administration of the former gave a higher pyruvate level [22]. Mukherjee et al [18] had shown that sucrose diet increased the cholesterol level of rats while the sucrose and fructose diets raised the neutral lipids. Similar observations had been made in monkeys [19] and in man [20]. Yamamoto et al [28] had shown that animals fed sucrose and fructose had a high rate of *de novo* synthesis of triacylglycerol from small, carbohydrate-derived precursors, and this is also associated with a high rate of output of very low density lipoproteins (VLDLs).

It has also been suggested [21] that dietary carbohydrates stimulate triacylglycerol formation by increasing the activities of several rate-determining enzymes of lipogenesis such as fatty acid synthetase and malic enzyme.

The delayed clearing of the triacylglycerols from the blood could partly account for the raised levels of total lipids. Mann and co-workers [23] pointed out that the insulin response to meals containing sucrose rather than polymers of glucose tends to be slow. Bruckdorfer and Baker [24], and Hirano et al [25] linked the elevation of serum triacylglycerol and cholesterol to the increased synthesis of VLDLs, but a decrease in the rate of removal of these lipoproteins from circulation due to their glycosylation.

The honey diet did not cause much elevation of the blood lipids as the sucrose, fructose, and even glucose, so we propose that the honey most probably contains some substances which in some way temper the lipogenic effect of fructose and glucose. This is in line with the suggestion that the constituents of a diet could mask the effect under investigation (in this case lipogenicity) even though that effect is present in the diet [26].

## CONCLUSION

It has been found that of the refined sugars, sucrose caused the greatest elevation of mean blood glucose, serum cholesterol and total serum lipids. On the other hand, compared to the refined sugars, honey caused the least elevation of these analytes.

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