

### **Metabolic Implications of Ramadan Fasting in Healthy Volunteers**

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#### **Introduction**

Fasting has been practised as a common denominator for almost every religion, in every part of the world. During the month of Ramadan all healthy muslim adults are required to observe total abstinence from food and water from the early hours of the morning till sunset, when they are permitted to terminate the fast and feed themselves again until the next morning. The usual fasting time is between 12 to 18 hours depending on the solar month it falls into, and the geographic location of the place of residence.

Changed pattern of food intake, and the differences in the quality and quantity of the food consumed during Ramadan may have metabolic implications. There is a tendency to over-eat both at the time of Sehri (main meal in the early morning) and Iftar (meal at termination of the fast at sunset), lots of liquid are consumed at this time together with sweets and fruits etc. Generally, no untoward effects are observed in healthy people due to this pattern of fasting and re-feeding except that in the summer months, when it is extremely hot, people feel very thirsty and some dehydration symptoms may manifest themselves, which, however, quickly disappear as the fast is terminated at sunset. There is also a tendency to cut down the physical activity in an effort to save energy and reduce food and water requirements.

However, for those who are old, weak or suffer from a debilitating disease like diabetes or heart disease, fasting during Ramadan may have deleterious effects and is discouraged by tradition.

There are few reports in the literature on Ramadan fasting Gumaa et al. [1] studied the serum uric acid and lipid concentrations during one month of starvation and re-feeding. They found linearly increased serum uric acid level which was positively correlated with the increase in serum triglycerides but not with cholesterol and phospholipids. Mustafa and co-workers [2] examined the fluid and electrolyte balance and concluded that healthy young adults maintain good control of fluids and electrolytes during Ramadan fasting. Fedail et al. [3] investigated the changes in some of the blood constituents at the beginning and the end of Ramadan. They found a significant increase in the levels of total serum cholesterol, thyroxine and uric acid but no significant change in the level of total serum triglycerides, triiodothyronine, gastrin and fasting insulin. They did not examine the distribution of cholesterol within the lipoprotein fractions.

The present studies were undertaken to assess the effect of Ramadan fasting on general body metabolism by examining the level of glucose, free fatty acids, total cholesterol and the HDL-

bound cholesterol in the morning and evening samples from the fasting volunteers in the last week of Ramadan. Serum electrolyte levels were also investigated.

### Material and Methods

Forty healthy volunteers (37 males and 3 females) working with the PCSIR Laboratories, Karachi, were investigated. They belonged to the lower middle class and were residents of the PCSIR campus. Their mean ages ranged between 20 and 56 years (average age 38 years). Blood samples were withdrawn in the morning (after *Sehri*) between 0800-0830 hours and in the evening of the same day (before *Iftar*) between 1800-1830 hours. These investigations were undertaken during the last week of Ramadan when metabolic adaptations in response to the changed food pattern are likely to have already taken effect. For comparison with the normal food pattern, blood samples were withdrawn from 20 subjects from among the same volunteers in the morning (two hours after breakfast) during the month subsequent to that of Ramadan. Same parameters i.e., glucose, total cholesterol, HDL-cholesterol and free fatty acids were estimated in the serum samples. Glucose and cholesterol samples were estimated with the help of diagnostic kits purchased from Merck (West Germany). For the separation of low density lipoproteins (LDL) and very low density lipoproteins (VLDL) from the high density lipoproteins (HDL), method of Burstein *et al.* [4] was used with slight modifications. Briefly, LDL and VLDL-bound cholesterol was precipitated by adding 20  $\mu$ l of sodium phosphotungstate and 50  $\mu$ l of magnesium chloride to 2 ml of the serum. After mixing in a vortex mixer, the sample was centrifuged at 1500 x g, for one hour at 4°C. HDL-

cholesterol was then estimated in the supernatant. Free fatty acids (FFA) were estimated by the method of Dole [5].

Investigations on the serum electrolytes were carried out on 20 volunteers. Blood samples were similarly withdrawn in the morning and evening during the first and the last week of Ramadan. Levels of sodium, potassium, chloride and bicarbonate in the serum were estimated. Serum sodium and potassium were analysed by flame photometer, whereas, chloride and bicarbonate were estimated by the method of Schales and Schales [6,7] and by micro-gasometry with Kopp-Natelson gasometer. First week levels of electrolytes were compared with those of the last week to see possible changes occurring over the month due to restricted water-intake. In this comparison, first week levels were considered as control.

### Results

Table-I, shows the level of various blood constituents in the serum of volunteers during the last week of the month of Ramadan as well as during the month subsequent to that of Ramadan. Comparison of these components between the morning and evening samples showed no significant difference in the case of total cholesterol, HDL-cholesterol or the F.F.A. However, there was a significant decrease in the level of glucose in the evening samples (from 106.79 mg to 87.45 mg/dl). When the non-fasting control morning glucose levels were compared with the evening levels in the month of Ramadan, it was observed that the level of glucose was almost of the same order (84.76 mg/dl and 87.45 mg/dl). HDL-cholesterol level was also not significantly different, nor

\* 40 gm phosphotungstic acid/litre in a mixture of NaOH (1 mol/litre) and distilled water

Table-I: Levels of various constituents in the serum of volunteers (mean  $\pm$  S.E.M)

Blood Constituents	Non-fasting Controls	During Ramadan Fasting	
	Morning Samples	Morning Samples	Evening Samples
Glucose (Mg/dl)	84.76 $\pm$ 7.06* (20)	106.79 $\pm$ 2.99 <sup>a</sup> (36)	87.45 $\pm$ 2.08 (36)
Total Cholesterol (Mg/dl)	197.50 $\pm$ 6.89 (20)	201.49 $\pm$ 6.24 (40)	206.75 $\pm$ 5.68 (38)
HDL-cholesterol (Mg/dl)	80.55 $\pm$ 10.38* (20)	72.13 $\pm$ 2.77 (38)	73.05 $\pm$ 2.74 (37)
Free fatty acids (M.moles/litre)	0.7290 $\pm$ 0.003 (20)	0.7730 $\pm$ 0.030 (20)	0.7740 $\pm$ 0.050 (20)

\* P 0.05, when values were compared with the fasting morning samples and the non-fasting morning (control) samples.

<sup>a</sup>P 0.05, when fasting morning samples were compared with the fasting evening samples.

was there any significant change in the free fatty acid levels in the fasting samples when compared with the non-fasting control samples.

Table-II, shows the levels of sodium, potassium, chloride and bicarbonate in the serum of fasting volunteers during the first and the last week of Ramadan. No significant difference was found in the levels of the electrolytes when morning and evening samples were compared. There was a slight upward trend in the values when the first week samples were compared with the last week samples. However, the difference was statistically non-significant.

### Discussion

Evaluation of the blood constituents in the serum of fasting volunteers was done to see if there were any signifi-

cant changes in the metabolism of nutrients and electrolytes in the morning and evening samples in the beginning (first week) and the end (last week) of the month of Ramadan. We observed no significant changes in the level of total cholesterol, HDL-cholesterol or FFA in the evening samples. Glucose level, however dropped significantly but the level was still in the normoglycemic range and hypoglycemia did not occur. The level of glucose in the evening samples of fasting volunteers was almost of the same order as found in the morning samples of the non-fasting volunteers, which means that even after a lapse of 10 hours of active fasting, the serum glucose level had been adequately maintained. This may be due to over nourishment at the time of Sehri because consumption of food is maximum at this time. It seems that the storage of glycogen in the liver

Table-II: Level of sodium, potassium, chloride and bicarbonate in the serum of fasting volunteers (Mean  $\pm$  S.E.M.)

Electrolytes (m Eq/litre)	First week of Ramadan*		Last week of Ramadan	
	Morning samples	Evening samples	Morning samples	Evening samples
Sodium	135.4 $\pm$ 0.36 (20)	136.8 $\pm$ 0.51 (20)	136.9 $\pm$ 0.070 (20)	138.78 $\pm$ 0.65 (18)
Potassium	4.11 $\pm$ 0.005 (20)	4.55 $\pm$ 0.005 (20)	4.25 $\pm$ 0.074 (20)	4.47 $\pm$ 0.087 (18)
Chloride	101.35 $\pm$ 0.43 (20)	102.35 $\pm$ 0.61 (20)	102.55 $\pm$ 0.80 (20)	103.94 $\pm$ 0.61 (18)
Bicarbonate	25.08 $\pm$ 0.29 (20)	25.25 $\pm$ 0.02 (20)	25.18 $\pm$ 0.19 (20)	25.02 $\pm$ 0.15 (18)

\*Control Group

reaches its maximum and the normoglycemia is maintained by periodic glycogenolysis as per requirements of the body. In the case of cholesterol, we observed a slight upward trend in the fasting serum levels when compared with those of the control but the difference was statistically non-significant. In this respect our data are in agreement with those of Gumaa *et al.* [1] who likewise did not find a significant change in the serum cholesterol levels during Ramadan fasting. They estimated cholesterol and other lipid values at various intervals during fasting and found 4%, 8% and 7% decrease in cholesterol levels. However, this change was statistically non-significant. We also examined the levels of cholesterol bound to high density lipoproteins (HDL-cholesterol) but here again the difference was not significant. Similarly the free fatty acid levels were also in the normal range. This shows that the requirements of energy are adequately met during the fasting period through

glucose, and lipids are not mobilised to the extent that may cause raised serum levels of free fatty acids.

Comparing the levels of sodium, potassium, chloride and bicarbonate in the serum of fasting volunteers we did not find any significant difference in the levels of electrolytes between the morning and the evening samples. A slight upward trend was noticed on comparing the first week levels with the last week levels, but the difference was non-significant. This shows that under the prevailing conditions at the time of investigation, the levels of electrolytes were maintained within the normal range during fasting hours. This may be due to avoidance of heavy physical activity and exposure to hot weather by staying indoors for most part of the fasting period.

A number of factors like duration of fast, temperature of the day, vocation (requiring less or more physical activity) and the amount of fluids

consumed at Sehri would influence the status of electrolytes. Those indulging in more physical activity and/or exposure to hot weather may show disturbed electrolyte balance. However, such activity during Ramadan is deliberately avoided.

The results of this preliminary study show that during Ramadan fasting, hypoglycemia is not generally produced, lipids are not mobilised to any great extent and the electrolyte balance is normally maintained. It may, therefore, be inferred that fasting by healthy people during Ramadan may not lead to metabolic aberrations of any significance.

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