Research Article

Effect of Ramadan Fasting on Body Composition, Biochemical Profile, and Antioxidant Status in a Sample of Healthy Individuals

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Abstract

Background: Muslims fast during the month of Ramadan by abstinence from food and drink every day from dawn to sunset. Studies have reported contradictory results with respect to the changes in body weight and biochemical parameters. No study has been conducted on the association between fasting and body weight and biochemical parameters in the Indian setting on healthy Muslim subjects.

Objectives: To assess the effect of fasting during Ramadan on biochemical parameters such as lipid profile, liver function test, renal function test, antioxidant status, random blood sugar, hemoglobin, body composition, and blood pressure in a sample of healthy individuals.

Methods: In this study, 52 healthy free-living participants (25 males, 27 females, 21-64 years) who met the inclusion and exclusion criteria and completed both follow-ups (before and after Ramadan) were studied. Participants were fasting 12 hours a day for at least 21 days, including menstruating women. It was a free-living study with no dietary restrictions. Anthropometry, lipid profile, liver and renal function tests were measured by standard methods. Body composition was analyzed by bioelectrical impedance.

Results: Significant beneficial changes in albumin, alanine aminotransferase, creatinine, and high-density lipoprotein (HDL) were observed, while total cholesterol, random blood sugar, aspartate aminotransferase, and alkaline phosphatase enzymes remained unchanged after Ramadan. Fasting did bring in some changes in body composition; among both men and women, mean weight loss ranged from 0.81 - 1.4 kg in majority of the subjects, which was due to loss in muscle mass. Moderate changes in intra- and extracellular water content was observed after fasting.

Conclusions: Significant improvements were observed in HDL levels and liver function tests, which can be attributed to the loss of body weight. Improvement in liver function tests may be related to the changes in cytokines and alteration in sleep patterns. Ramadan-like fasting, along with the nutritional education prior to fasting, may be beneficial and effective in the spiritual and overall well-being.

Keywords: Ramadhan, Healthy Subjects, Body Composition, Liver, Renal Function, Lipid Profile, India.

1. Background

Ramadan is the ninth month of the Islamic calendar and the month in which Muslims are obliged to fast from dawn to sunset for 29-30 days across the world, consuming one meal before the sunrise ('suhoor' or 'sehri') and another after the sunset ('iftar'). During fasting, the food frequency, quantity, sleep duration at night, and exercise are reduced (1).

A study carried out by Yoshinori Ohsumi, a Japanese scientist who won the noble prize in 2016, discovered the principle of fasting, which helps us to stay young and healthy. He argued that when we starve for some time, the cells recycle everything which is unwanted and become young, a process known as 'autophagy' (2).

Intermittent fasting contributes to restoring homeostasis. The cells respond to intermittent fasting by engaging in the coordinated adaptive stress response that leads to increased expression of antioxidant defense, DNA repair, protein quality control, mitochondrial biogenesis and autophagy, and downregulation of inflammation (3).

An animal study reported that the mean lifespan of rats who were on a regimen of alternate-day feeding was increased by 80% (4).

Also, a meta-analysis study on data from 1934 to 2012 revealed that calorie restriction in rats is associated with

increased median lifespan by 14 to 45% (5).

Studies have reported that fasting is associated with improved biochemical parameters and reduced risk of many metabolic disorders such as obesity, metabolic syndrome, hypertension, hypercholesterolemia, CVD, type 2 diabetes, and chronic kidney disease. However, there are studies which reported controversial results, including unfavorable effects on metabolic parameters and probable increasing of CVD risk, due to physiological changes induced by Ramadan fasting, which can be attributed to several confounding factors like gender, age, ethnicity, number of days of fasting, hours of fasting, cultural influence, climatic conditions, the study subjects, sample size, exercise, genetic background, and the dietary pattern (1). Though fasting is safe for healthy individuals, those with metabolic and other chronic diseases are recommended to consult their physicians before fasting (6).

2. Objectives

Based on our literature survey and to the best of our knowledge, this is the first study in India that has investigated the effects of Ramadan fasting on biochemical parameters and body composition in healthy subjects, except for the study reported by Chandalia et al. (1987) on diabetic subjects (7).

3. Methods

This is a prospective study conducted in the month of Ramadan (May-June 2019) on a sample of healthy Muslims to investigate the effects of fasting on blood parameters and body composition. The study was conducted in the Department of Studies in Food Science and Nutrition, University of Mysore, Mysuru, Karnataka, India. A questionnaire was designed to collect information pertaining to demographic profile, anthropometric data, and regular food patterns during Sehari (just before fasting) and Iftar (break of fast), as well as the total number of skipped fastings.

Written informed consent was obtained from all participants. Besides, the study is approved by the Institutional Human Ethics Committee affiliated to the University of Mysore (IHEC-UOM No.67/Res/2019-20). Subjects were recruited based on willingness through personal acquaintances, social media platforms, and News Paper advertisement.

Healthy subjects of both gender (> 20 y and < 65 y) were included. Those with chronic diseases and receiving any medical treatment, past history of surgery and implantation, and pregnant and lactating women were excluded.

The anthropometric, body composition and biochemical parameters were measured and analyzed two days prior to the beginning of the month of Ramadan (pre-fasting) and two days after the completion of Ramadan fasting (post-fasting). The anthropometric measurements included height, weight, body mass index (BMI), and waist to hip ratio (WHR). Parameters such as body fat, muscle mass, intracellular water (ICW), and extracellular water (ECW) were estimated using body composition analyzer based on bio-electrical impedance (Inbody 770, South Korea). Blood samples for biochemical analysis were collected after an overnight fast, and a minimum gap of 3 hours post-consumption of last meal was ensured for body composition analysis.

Finger prick blood samples were used for Haemoglobin (Hb) by Mission Haemoglobin Testing System (San Diego, USA) and Random Blood Glucose (RBS) by Arkray Glucocard (Shiga, Japan). Five ml of the blood sample was drawn and centrifuged at 3000 rpm for 5 min. Serum was analyzed for urea, creatinine, lipid profile (total cholesterol, HDL, and triglycerides), liver enzymes (ALT, AST, and ALP), total protein, albumin using diagnostic kits (Agappe diagnostics LTD, Mumbai, India). Serum antioxidant status was evaluated using the Ferric Reducing Antioxidant Power method (8) in Robonik prietest touch plus Biochemistry Analyzer. Blood Pressure (BP) was checked using Easy Care Digital BP Monitor EC 9900 (Germany). LDL values were calculated using the formula (9);

$$LDL = 0.75 \, total \, cholesterol \\ - 0.5 \, HDL - 0.1 \, triglycerides$$

All subjects underwent the above measurements pre and post fasting period.

Commonly consumed foods during Seheri and Iftar were recorded during their visit to understand the dietary pattern.

Statistical analysis was performed using the statistic software package (SPSS, 16.0, International Business Machines, USA). Descriptive statistics were reported as Mean $\pm$ SD. The paired sample t-test was used to compare the pre and post mean values of anthropometric, body composition, biochemical, and lipid profiles.

4. Results

4.1. Impact of Fasting on Anthropometry and Body Composition

A total of 69 volunteers participated at the start of the study, out of which 17 of them failed to give blood samples at the end of the study. The mean age of the 52 subjects who completed the study (M-25, F-27) was 37.8 $\pm$ 12.07y. The changes in anthropometric parameters and body composition of participants are described in Table 1, and changes

in somatic parameters are described in Table 2. The majority of subjects were found to be overweight according to the BMI classification for Asians (10), pre- and post-fasting. The mean body weight of males and females was 77.4 ± 13.7 kg and 65.0 ± 11.6 kg, respectively, while for the BMI it was 27.0 ± 4.8 kg/m^2 and 27.4 ± 4.1 kg/m^2 for males and females, respectively. The post fasting values of weight and BMI were significantly lower (P < 0.05) than pre fasting, indicating the impact of Ramadan fasting. The average hours of Ramadan fasting in India is 13 - 14 hours. In our study, the mean weight loss of males and females was 1.4 ± 1.2 kg and 0.8 ± 0.5 kg, respectively, which may be due to reduced muscle mass (men - 0.48 ± 0.31 kg; women - 0.43 ± 0.27 kg). A significant loss of muscle mass (P < 0.01) was observed for all participants, with a mean difference of 0.3 kg in males and 0.25 kg in females, from pre- to post-fasting which may be due to reduced physical activity. The majority of subjects had gain weight (males: 1.0 ± 0.8 kg and females: 0.88 ± 0.64 kg); however, no significant difference (P > 0.05) was observed. WHR was almost similar for both sexes. The mean fat % was higher than the normal values (18-28%) for both males and females, with no significant change (P > 0.05). A significant difference (P < 0.05) was observed in ECW irrespective of gender, whereas, for ICW, no significant difference was observed in males. Also, moderate changes were observed in ICW and ECW content post fasting.

4.2. Changes in Biochemical Composition

The changes in blood parameters are provided in Table 3. A significant change (P < 0.01) was observed in albumin content, irrespective of gender. Besides, liver enzymes such as AST were also increased to 19.5 ± 9.1 U/L (P < 0.01) in males and 16.2 ± 6.9 U/L in females, whereas ALT decreased to 9.3 ± 6.0 U/L (P < 0.01) in males and 8.2 ± 4.1 U/L in females. There was no significant difference in total protein, ALP, antioxidant status, random blood sugar, hemoglobin, and blood pressure levels. The creatinine levels were also reduced significantly (P < 0.05) from 0.86 ± 0.24 to 0.77 ± 0.14mg/dL in males and 0.72 ± 0.15 to 0.67 ± 0.09mg/dL in females post-fasting. However, the values were within the normal range (0.4-1.4mg/dL). No significant difference was observed in the urea levels due to fasting, and the values were within the normal range (10-50mg/dL) for both genders.

Changes in the lipid profile are depicted in Table 4. A significant improvement was observed in the HDL levels (post-fasting = 56.8 ± 10.7mg/dL in men; 65.2 ± 18.1mg/dL in women) and the values were within the normal range for both genders (35-80 mg/dL and 42-88 mg/dL, respectively). A significant reduction in the LDL values was observed for both genders in post-fasting (P < 0.05). The

mean triglycerides level was increased significantly (P <0.01) in males compared to the baseline (from 190.9 ± 89.4mg/dL to 247.7 ± 106.6mg/dL) and was higher than the normal ranges (i.e., 60-165 mg/dL), whereas in women, no significant difference was observed, although the values were higher than the normal range.

Investigating the dietary habits of participants revealed that most of them had a similar dietary pattern. It was observed that the consumption of flesh foods, dry and fresh fruits, vegetables, and dairy products is a common practice followed by the Muslim community during the time of Ramadan.

5. Discussion

5.1. Changes in Anthropometric Measurements and Body Composition

To the best of our knowledge, this is the first study in India that reported the effects of Ramadan fasting on biochemical parameters and the body composition in healthy participants. The effect of fasting on weight loss, BMI, and loss of fat-free mass reported in the present study were similar to findings reported by Sadeghirad et al. (2014) and Fernando et al. (2019) (11, 12). Although a reduction was observed in muscle mass, the values remained within the normal range (19.9-24.3 Kg). We observed a significant loss in fluid compartments (ICW and ECW) between pre and post fasting. Loss of water can be attributed to glycogen losses and electrolyte imbalance (13). Fasting has a significant effect on body composition. In the present study, body weight and BMI were decreased, whereas WHR and body fat percentage were increased moderately post-Ramadan. Our observations are in agreement with the study by Fakhrzadeh et al. (2003) (14). In contrast, a study reported that body composition was not affected during fasting. In a study on young men, the increase in weight is attributed to high macronutrient intake during Ramadan. This inconsistency may be due to various characteristics of participants, particularly age, sex, and physical activity, as well as the duration of fasting, which varies according to the geographical location (12). In the present study, systolic and diastolic blood pressures were decreased, perhaps due to catecholamine inhibition during hunger, which is supported by the findings of Shehab et al. (2012) (15).

5.2. Changes in the Biochemical Composition

The increase in markers of renal function during Ramadan may be caused by dehydration. Additionally, increased urea concentrations may be explained by increased protein breakdown and/or decreased renal blood flow. Some studies have also suggested that increased urea

Table 1. Changes in Anthropometric and Body Composition Parameters of Pre and Post Ramadan Fasting[a,b]

Somatic Status	Men (n=25), Mean (SD)				P Value	Women (n=27), Mean (SD)				P Value
	Pre	%CV	Post	%CV		Pre	%CV	Post	%CV	
Weight (Kg)	78.2 (14.6)	18.7	77.4 (13.7)	17.8	0.016	65.6 (11.5)	17.6	65.0 (11.6)	17.9	0.001
Waist-hip ratio	0.93 (0.07)	7.8	0.94 (0.06)	6.7	0.161	0.90 (0.04)	4.4	0.91 (0.05)	6.0	0.095
Body mass index	27.3 (5.1)	18.9	27.0 (4.8)	18.0	0.014	27.6 (4.0)	14.7	27.4 (4.1)	14.9	0.001
Muscle mass (Kg)	30.5 (3.7)	12.1	30.1 (3.6)	12.1	0.001	19.9 (3.1)	15.6	19.6 (3.0)	15.5	0.006
Body fat (%)	29.0 (9.6)	33.2	29.3 (8.7)	29.9	0.314	42.7 (5.7)	13.5	42.9 (5.7)	13.4	0.440
Intracellular Water (L)	24.8 (2.9)	11.6	24.6 (2.8)	11.4	0.122	16.8 (2.3)	14.1	16.6 (2.3)	14.1	0.006
Extracellular Water (L)	15.0 (1.7)	11.7	14.9 (1.8)	12.1	0.033	10.4 (1.5)	15.1	10.3 (1.5)	14.4	0.026

[a] Total Group's means for pre and post values were compared using paired sample t-test.
[b] A P value of less than 0.05 was considered as statistically significant.

Table 2. Changes in Somatic Parameters Among Subjects[a]

Variable	Men	Women
Body weight		
Loss	-1.4 ± 1.2 (72)	-0.81 ± 0.55 (74.07)
Gain	0.75 ± 1.0 (28)	0.38 ± 0.31 (18.52)
No change	0 (0)	0 (7.41)
Muscle mass		
Loss	-0.48 ± 0.31 (88)	-0.43 ± 0.27 (70.37)
Gain	0.50 ± 0.34 (12)	0.35 ± 0.23 (25.93)
No change	0 (0)	0 (3.70)
Body fat		
Loss	-0.91 ± 0.52 (40)	-0.90 ± 0.65 (37.04)
Gain	1.0 ± 0.80 (60)	0.88 ± 0.64 (55.56)
No change	0 (0)	0 (7.41)
Waist-hip ratio		
Loss	-0.016 ± 0.007 (36)	-0.018 ± 0.009 (37.04)
Gain	0.03 ± 0.04 (36)	0.03 ± 0.01 (48.15)
No change	0 (28)	0 (14.81)

[a] All values are mean ± standard deviation (%).

concentrations may be caused by high energy expenditure and reduced energy intake (16). A significant increase was observed in the albumin irrespective of gender. Albumin makes up approximately 60% of the total serum proteins, and its major function is maintaining the colloidal osmotic pressure. The increased concentration of albumin levels after Ramadan may be due to hemoconcentration because of dehydration. There was no significant change in total protein. However, Kamal et al. (2012) argued that decreased levels of total protein may be due to proteolysis or gluconeogenesis (17). When 80% of stored fat is consumed, an intensive breakdown of protein begins, which enters the metabolic pathway. Therefore, during fasting, due to the lack of amino acid from the gastrointestinal tract, protein regeneration decreases. The reduction in serum creatinine values could be due to loss of muscle mass during the fasting period. Also, liver enzymes were changed at the end of Ramadan but still were at normal range and clinically insignificant. Moderate changes in the liver enzymes might be due to the changes in the cytokines and alteration in circadian rhythms of hormones during Ramadan fasting.

There was no significant change in the antioxidant status from pre to post fasting, but the moderate increase in the values may be due to the high intake of fresh vegetables and fruits, which are rich sources of antioxidants. The non-significant increase in the hemoglobin level may be due to the reduction in the body fluids, which in turn may have resulted in a slight increase in the Hb levels (11). These findings are in agreement with those reported by Farshidfar et al. (2006), who observed a slight increase in Hb levels after Ramadan fasting (18).

In the present study, despite high fat intake, which is common during Ramadan, HDL levels were improved, which is consistent with the findings of other studies (19-21). Reduction in average cholesterol levels was observed in post fasting, but the difference was not statistically significant. Similar results are reported by studies conducted in other ethnic groups of different geographical locations (14, 22). Serum triglyceride levels were increased in both genders, but it was statistically significant only in males. The non-significant increase in serum triglyceride levels in females at the end of the fasting may be attributed to the lipolytic effect of prolonged fasting, which is in line with the study by Mansi and coworkers (19). Studies have reported heterogeneity on the impact of Ramadhan fasting on lipid profile. The changes in lipid profile, however, may vary depending on the quality and quantity of food intake and physical activity. Other lifestyle changes, especially for more frequent and voluntary prayers, which is comparable to moderate exercise performed during Ramadan, may lead to a healthier outcome (15).

Table 3. Changes in Biochemical Parameters Before and After Ramadan Fasting[a,b]

Biochemical Parameters	Men (n=25), Mean (SD)				P Value	Women (n=27), Mean (SD)				P Value
	Pre	%CV	Post	%CV		Pre	%CV	Post	%CV	
Total protein (g/dL)	6.8 (1.0)	14.92	7.2 (0.94)	12.9	0.139	6.6 (0.98)	14.8	6.8 (0.74)	10.9	0.514
Albumin (g/dL)	4.8 (0.86)	17.8	5.6 (0.40)	7.15	< 0.0001	5.1 (0.51)	10.0	5.5 (0.32)	5.7	0.001
Urea (mg/dL)	18.8 (5.0)	26.5	19.1 (4.3)	22.4	0.706	17.1 (4.8)	28.4	18.1 (6.1)	33.8	0.373
Creatinine (mg/dL)	0.86 (0.24)	28.3	0.77 (0.14)	18.2	0.031	0.72 (0.15)	21.6	0.67 (0.09)	13.3	0.014
Aspartate aminotransferase (U/L)	12.3 (8.1)	66.0	19.5 (9.1)	46.6	0.001	11.5 (7.7)	67.0	16.2 (6.9)	42.8	0.014
Alanine aminotransferase (U/L)	15.3 (7.0)	46.2	9.3 (6.0)	64.7	< 0.0001	12.0 (3.4)	28.8	8.2 (4.1)	50.7	< 0.0001
Alkaline phosphatase (U/L)	240.9 (49.9)	20.7	243.2 (70.4)	28.9	0.825	248.9 (40.9)	16.4	251.0 (65.7)	26.1	0.852
Antioxidant status (mmol/L)	1.2 (0.26)	21.7	1.2 (0.19)	15.9	0.492	1.0 (0.26)	25.4	1.0 (0.23)	23.0	0.874
Random Blood Sugar (mg/dL)	106.1 (19.7)	18.5	116.4 (32.8)	28.1	0.092	115.1 (35.2)	30.6	116.9 (29.0)	24.8	0.538
Haemoglobin (g/L)	14.1 (1.1)	8.2	14.6 (1.9)	13.0	0.141	12.2 (1.1)	9.8	12.1 (1.5)	12.8	0.784
Systolic Blood Pressure (mmHg)	124.5 (10.7)	8.6	124.1 (12.3)	9.9	0.891	116.4 (19.3)	16.6	121.0 (16.8)	13.9	0.047
Diastolic Blood Pressure (mmHg)	77.5 (8.9)	11.5	76.2 (9.5)	12.5	0.527	75.4 (10.6)	14.1	78.0 (9.4)	12.0	0.092

[a] Total Group's means for pre and post values were compared using paired sample t-test.
[b] A P value of less than 0.05 was considered as statistically significant.

Table 4. Changes in Lipid Profile Before and After Ramadan Fasting[a,b]

Lipid Profile	Men (n=25), Mean (SD)				P Value	Women (n=27), Mean (SD)				P Value
	Pre	%CV	Post	%CV		Pre	%CV	Post	%CV	
Cholesterol (mg/dL)	156.8 (34.1)	21.7	155.3 (40.7)	26.2	0.822	152.0 (40.4)	26.6	150.9 (31.8)	21.0	0.852
Triglycerides (mg/dL)	190.9 (89.4)	46.8	247.7 (106.6)	43.0	0.009	179.0 (88.4)	49.3	198.1 (81.3)	41.0	0.210
HDL (mg/dL)	47.1 (11.2)	23.8	56.8 (10.7)	18.8	< 0.0001	52.1 (13.7)	26.3	65.2 (18.1)	27.8	< 0.0001
LDL (mg/dL)	75.0 (20.9)	27.9	63.3 (28.9)	45.6	0.023	70.0 (25.9)	37.0	60.8 (19.7)	32.5	0.033

Abbreviations: HDL, high density lipoprotein; LDL, low density lipoprotein.
[a] Total Group's means for pre and post values were compared using paired sample t-test.
[b] A P value of less than 0.05 was considered as statistically significant.

The major findings of our study include a significant increase in HDL, albumin, AST, and triglycerides, and a significant decrease in body weight and ALP after Ramadan. However, the prolonged effects of post-Ramadan were not investigated in the current study. Some studies have demonstrated a beneficial effect of Ramadan fasting on anthropometric parameters and other metabolic conditions. The differences in the results can be attributed to several factors, which include differences in the study protocols and dietary habits, and differences in climates and variations in the seasonal occurrence of Ramadan. Though the Ramadan month in the present study was in peak summer, mild dehydration resulted in an increase in Hb and a moderate decrease in the cellular fluids. Despite this, the effect of dehydration on fasting during Ramadan resulted to be beneficial without any detrimental effect. Our results highlight potentially relevant health benefits of fasting during Ramadan.

5.3. Limitations

The present study has evaluated the impact of fasting on body composition and biochemical parameters in a sample of healthy individuals in Mysuru city. One of the main limitations of the present study is selecting participants using a convenience sampling technique. Also, since it was not possible to perform a controlled study, we used a free-living design.

In conclusion, this study demonstrated that Ramadan fasting is beneficial in improving the biochemical parameters such as HDL levels and LFT, which is due to loss of body weight. Moderate improvement in LFT may be related to the changes in cytokines and alteration in sleep patterns. Therefore, Ramadan-like fasting, along with nutrition education before the start of fasting, may be more beneficial and effective in the spiritual and overall well-being. Several studies have mentioned wide variations in the lipid profile, which can be attributed to factors such as ethnicity, geographical areas, and dietary choices during Ramadan fasting.

Acknowledgments

Footnotes

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