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Research Article

Possible Anti-Diabetic and Anti-Hyperlipidemic Efficacy of Blended Rice Bran Oil with Sesame Oil in Comparison with Soybean Oil: A Clinical Investigation in Pre-Diabetic and Diabetic Individuals

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ABSTRACT

Objective: Cooking oil is an important ingredient of the diet and type of cooking oil used can affect the incidence and progression of metabolic disorders. It is established that mono and polyunsaturated fatty acids lowers the risk of diabetes or helps in better management of diabetes. The blend of rice bran oil and sesame oil contains PUFA and MUFA in nearly recommended levels. The present study was planned to evaluate and validate effect of blend of Rice BranOil and Sesame Oil (RBSO) in subjects with type II diabetes.

Research design and methods: Fifty one diabetic patients were randomized to receive either Fortune vivo blended rice-bran oil (RBSO; n=26) or the comparator soybean oil (n=25). RBSO was given to 29 non-diabetic, 28 pre-diabetic controls. The amount of cooking oils was given for the entire family as per the recommended daily dietary requirement for 12 weeks.

Following 12 weeks of study and a subsequent wash-out period of 21 days, 12 patients were randomly selected from each arm of the 2 diabetic patient groups and were crossed over to receive the other study oil and evaluated every 4 weeks for another 12 weeks in a similar manner as before

Results: There was reduction in FBS and PPBS across all RBSO groups, but was significant only in the diabetic patients (p=0.010). There was no significant change in FBS or PPBS levels observed in soybean oil treated group. RBSO treated diabetic group showed 9.5% reduction of HbA1c while it was elevated in the soybean oil group.

Both RBSO and soybean oil were well tolerated by all subjects and no adverse event was noted in any study group.

Conclusion: In the present study, RBSO appeared to improve sugar metabolism as evidenced by reduction in FBS, PPBS and HbA1c in type-2 diabetic patients.

Keywords: Cooking oil; Sugar metabolism; FBS or PPBS; Soybean oil

INTRODUCTION

Type 2 Diabetes is associated with chronic hyperglycemia due to metabolic disorders caused by insulin resistance [1]. According to the International Diabetes Association (IDF), Diabetes is a global health challenge, affecting 425 million people worldwide and this number will rise to nearly 629 million by 2045. The increase in the incidence of type 2 diabetes is largely attributable to lifestyle changes including diet, increasing age and sedentary life [2]. The World Health Organization reported that A significant number of patients with type 2 diabetes die from cardiovascular diseases [3]. Obesity being major contributor of

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enhanced type II diabetes and is also cause of high morbidity and mortality. Cardiovascular diseases and diabetes account for approximately 50% of deaths due to non-communicable diseases [4].

Many researchers reported that dietary modification play significant and major role in management of diabetes and hyperlipidemia [5]. Cooking oil, an important ingredient of the diet, can impact the incidence and progression of metabolic diseases. Many researchers reported that consumption of saturated fatty acids enhances the risk of diabetes and other studies reported that consumption of mono and polyunsaturated fatty acids lowers the risk of metabolic disorders and help in better management of diabetes [6].

Rice bran oil typically contains 22% of SaturatedFatty Acid (SFA), 35% polyunsaturated fatty acid (PUFA) and 43% of Monounsaturated Fatty Acid (MUFA) and it is extremely close to the American Heart Association (AHA) and World Health Organization (WHO) recommendations on edible oils [7]. In addition to its fatty acid composition, the bioactive compounds like oryzanol, tocopherol etc. make it oil with a very powerful antioxidant activity and that scavenge free radicals and reduce damage caused by oxidative stress [8]. Sesame oil is edible oil derived from sesame seeds, is regarded as a healthy food, because it contains bioactive components such as tocopherols, polyphenols, flavonoids, phenolic ligands, sesamol, sesamin and sesamolin. These antioxidant constituents contribute in its anti-diabetic and antihypertensive properties. It is reported to lower blood glucose, glycatedhaemoglobin (HbA1c), and cholesterol levels [9].

Keeping in view, significance of rice bran oil and sesame oil in metabolic disorders, it was planned to evaluate the efficacy and safety of (RBSO) in subjects with type II diabetes. oil was used as comparator.

MATERIALS AND METHODS

Subjects

A total of 153 adults between the ages of 25 years to 65 years were screened for the study at All India Institute of Medical Sciences, Bhubaneswar, India. Twenty-nine non-diabetic, 28 pre-diabetic (FBG 100-125 mg/dL or HbA1c between 5.7-6.5%) and 51 diabetic (FBG ≥ 125 mg/dL or HbA1c ≥ 6.5% and on stable oral antidiabetic drugs for 4 weeks or more) subjects were selected in a random manner.

Patients with BMI ≥ 30 kg/m^2, consuming laxatives for more than twice a month, Consuming more ≥ 20 g alcohol per day and more than 10 cigarettes per day, lactating or pregnant mothers, regular users of rice bran oil, or sesame oil for last 3 months and those who take more than 2 major meals per week outside home or frequent travelers were excluded from the study. Both non-diabetic and pre-diabetic subjects were assigned FortuneXpert Pro Sugar Conscious Blend(RBSO) while the diabetic patients were further randomized to receive either Fortune Xpert Pro Sugar Conscious (RBSO)Blend or soybean oil as cooking oil medium. The oils were given for all family members for 12 weeks.

As a supplementary, following completion of the 12 weeks of primary study and 21 days of washout period, 12 diabetic patients each from RBSO and soybean oil group were crossed over to receive the other oil for another 12 weeks and evaluations were done in a similar manner. Fortune Vivo Rice bran Sesame Blend oil was given to the enrolled population.

Study design

The study designed was 4 arms, randomized, double blinded parallel-group clinical trial. Both the study oils were packaged in similar looking containers and coded to maintain blinding. Neither the investigator nor the patients were able to identify the received treatment. The subjects were asked to consume food according to their normal habits during the study without any personal restriction except they had to replace their cooking oil with the same quantity of the allocated investigational oil.

Ethical approval

The study protocol no. RBSO/10/2017 was duly approved by the Institutional Ethics Committee, AIIMS, Bhubaneswar, (India), and was registered with the ISRCTN (ISRCTN10484466). The study was performed in compliance and accordance with ICH guidelines for Good Clinical Practices (GCP), including the archiving of essential documents as per International Ethical Standards guaranteed by the Declaration of Helsinki and its subsequent amendments. Strict confidentiality was maintained throughout the study.

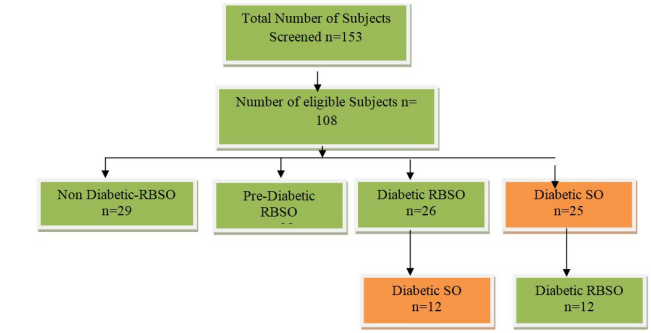

Figure 1: Study Flow Chart.

Study evaluation

The efficacy was evaluated by change in fasting, post prandial blood glucose and HbA1c levels12 at weeks from the baseline (0 week). Safety was assessed by liver and renal function tests, lipid profile, hemogramand oxidative parameters were performed on enrolment and on completion of the respective allocated oil consumption. All the investigations were done using validated diagnostic kits and auto-analysers at AIIMS Bhubaneswar Figure 1.

Sample size and data analysis

Considering an alpha error of 5% and SD of 0.125 in the measurement of HbA1c concentration with the expected difference in the change of 0.2 between the groups, 25 subjects

were required for providing 80% power to the study. Data was expressed as mean ± SD and analysis was done using ANOVA with post hocBonferroni's correction. P<0.05 was considered statistically significant.

RESULTS

Demographic parameters

Table 1 depicts the demographic parameters. The median age was 35 and 40 years in the nondiabetic and prediabetic group respectively. Whereas it was in 50 years in the diabetic groups. Percentage of male subjects was 41 and 87 in the non-diabetic and prediabetic group. In the diabetic subjects 69% and 80% weremale in the RBSO and SO groups respectively. Height, weight, Systolic BP and diastolic BP were comparable across all participant groups.

Table 1: Demographic distribution of study participants.

	Non-diabetic (RBSO)	Pre-diabetic (RBSO)	Diabetic	
			RBSO	SO
Age (yrs)	35.2 ± 9.6	40.6 ± 9.9	48.9 ± 8.8	51.1 ±10.0
Height (cm)	159.7 ± 6.9	163.1 ± 9.0	158.6 ± 9.3	163.6 ± 8.4
Weight (kg)	66.4 ± 10.5	72.1 ± 15.3	65.7 ± 11.5	73.1 ± 14.7
SBP	118.3 ± 12.9	130.1 ± 13.5	126.3 ± 14.7	130.3 ± 14.0
DBP	73.9 ± 8.5	77.6 ± 7.7	72.8 ± 9.9	77.5 ± 10.2

Data are expressed as mean ± SD

Fasting blood glucose levels

There was a consistent and significant reduction in the Fasting Blood Glucose (FBG) from 4th week onwards in the diabetic population on RBSO. After 12 weeks, the reduction was 19% (147.1 mg/dl to 118.0 mg/dl) from the baseline (p=0.005). When compared with soybean oil, RBSO produced 19% reduction in FBG after 12 weeks in the diabetic patients.The reduction in the FBG was observed in 81% of the diabetic subjects.

RBSO produced a minor and not significant reduction (5.5%) and no change in FBG in the non-diabetic group. Similar non-significant result was observedin the soybean oil group (2.4% reduction) (Table 2).

Table 2: Effect on FBG levels.

Timeline	Non-diabetic (RBSO)	Prediabetic (RBSO)	Diabetic (RBSO)	Diabetic (SO)
Baseline (0 week)	92.2 ± 8.7	101.6 ± 18.1	147.1 ± 5.1	138.1 ± 50.9
4th week	88.4 ± 8.4	98.6 ± 10.4	118.0 ± 25.8	131.0 ± 37.4
8th week	91.5 ± 9.8	97.8 ± 15.1	130.7 ± 40.7	138.8 ± 40.5
12th week	93.1 ± 6.8	96.0 ± 14.7	*118.0 ± 23.1	134.8 ± 24.7

Values (mg/dl) are expressed as mean ± SD, * (p=0.005).

Crossover fasting blood sugar levels

On comparison with Rice bran sesame Oil Blend with Soya oil, the decrease in FBS levels in diabetic subjects was 10.94% as compared to respective baseline value whereas in case of Soybean Oil the decrease was only 1.33%. The decrease in FBS level was significant (p=0.006). The RBSO group showed 4.97% lesser Fasting blood sugar levels as compared to SO group, whereas after crossover RBSO group showed 5.65% lesser FBS levels as compared to SO group (Figure 2).

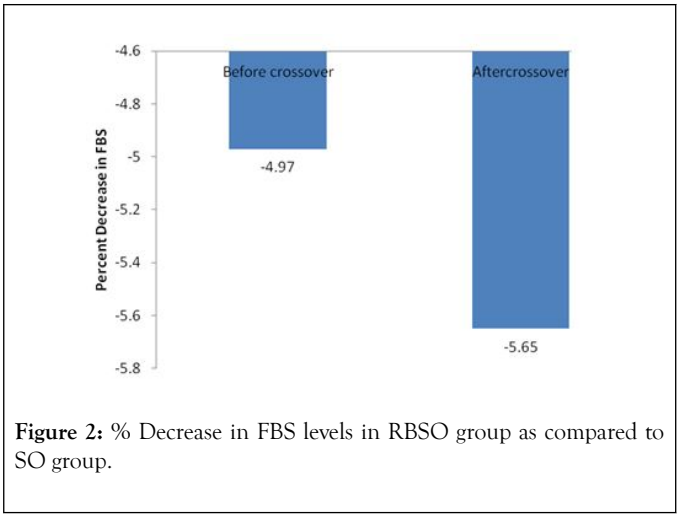

Figure 2: % Decrease in FBS levels in RBSO group as compared to SO group.

Post prandial blood glucose levels

Twelve weeks of RBSO use exerted postprandial reduction in blood glucose levels in both diabetic (18% reduction) and pre diabetic groups (8% reduction). However, the decrease was significant (p=0.010) in the diabetic group.

In the non-diabetic group, RBSO did not produce any significant change in the the PPBG values. The reduction in in

PPBG levels was observed in 69% of diabetic patients following 12 weeks of RBSO use (Table 3).

In comparison with RBSO, the decrease in PPBS levels in diabetic subjects was 18% as compared to respective baseline value whereas in case of soybean oil, the decrease was 7.6%.

Table 3: Effect on PPBS levels.

	Non Diabetic (RBSO)	Prediabetic (RBSO)	Diabetic (RBSO)	Diabetic (SO)
Baseline (0 week)	95.7 ± 21.6	122.0 ± 29.7	217.6 ± 79.4	199.6 ± 75.2
4th week	91.7 ± 15.7	113.4 ± 24.6	186.7 ± 51.9	184.8 ± 58.9
8th week	90.8 ± 17.8	117.9 ± 26.5	186.2 ± 61.2	202.3 ± 78.9
12th week	95.5 ± 16.2	112.1 ± 28.5	*178.4 ± 41.4	184.5 ± 61.7

Values (mg/dl) are expressed as mean ± SD, * (p=0.005).

Post prandialblood glucose levels(cross-over groups)

In comparison with RBSO, the decrease in PPBG levels in diabetic subjects was 16.8% as compared to respective baseline value whereas in case of Soybean Oil the decrease was 9.4%.

After the Oil change and 12 weeks of respective oil consumption, the mean PPBS value was 19.1% lesser in RBSO group as compared to SO group (Figure 3).

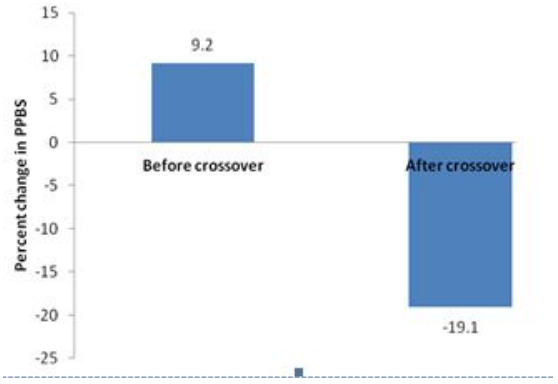

Figure 3: % Change in PPBS levels in RBSO group as compared to SO group.

Glycated hemoglobin levels (%)

Diabetic patients on RBSO for 12 weeks RBSO showed a reduction of HbA1c values from the baseline of 7.6% to 6.8%. The decrease was 9.5%. No significant change in HbA1c levels were observed in non-diabetic and Prediabetic group. In case of soybean oil there was 4.5% increase in HbA1c levels were observed (Figure 4).

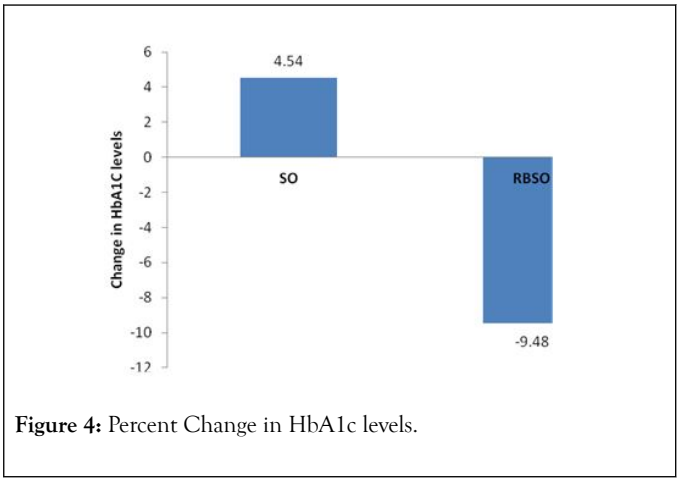

Figure 4: Percent Change in HbA1c levels.

Glycated hemoglobin in the crossover groups

On comparison with RBSO, the decrease in HbA1c levels in diabetic subjects was 11.5% as compared to respective baseline value whereas in case of soybean oil the decrease in HbA1c levels were 1.07%.

After the Oil change and 12 weeks of respective oil consumption, mean HbA1c levels for RBSO group were 6.94% and that of crossover SO group were 8.45%. The mean HbA1c value was 17.86% lesser in RBSO group as compared to SO group. A significant increase in HbA1c levels (p=0.0001) were observed in SO group as compared to its baseline value. After the crossover, the HbA1c levels were significantly (p=0.01) lesser in RBSO as compared to SO group. Also, HbA1c levels of diabetic subjects after consumption of 12 weeks of RBSO and Then crossover to SO were significantly lesser (p=0.0001) (Table 4).

Table 4: Effect on HbA1c levels in diabetic subjects before crossover.

Timeline	Before Crossover		CROSSOVER	After Crossover
	RBSO	Soybean oil	RBSO	Soybean oil
0 week	7.8 ± 2.45	6.5 ± 1.1	6.5 ± 0.76	6.9 ± 1.1
12 week	6.9 ± 1.1	6.5 ± 0.8	7.1 ± 1.00	8.5 ± 1.3

Values (mg/dl) are expressed as mean ± SD

Lipid profile

RBSO use for 12 weeks was associated with reduction of serum triglyceride levels by 31.4% (p=0.005) and 27.6% (p=0.008) compared to their respective baselines in the pre-diabetic and diabetic groups respectively. RBSO also caused a reduction in the VLDL levels significantly (p=0.001) after 12 weeks. However, the changes in Total cholesterol, HDL cholesterol and LDL cholesterol were non-significant in all the study groups (Tables 5 and 6).

Table 5: Effect on lipid profile.

	Non-Diabetic Group		Prediabetic Group		Diabetic Group	
	0 week	12 weeks	0 week	12 weeks	0 week	12 weeks
TC	186.8 ± 42.9	183.1 ± 38.3	200.5 ± 41.8	199.6 ± 40.5	199.1 ± 51.2	192.3 ± 51.0
TG	131.0 ± 80.6	123.2 ± 81.0	170.3 ± 115.0	116.9 ± 58.6	200.4 ± 112.0	145.1 ± 83.5
LDL	95.6 ± 27.3	95.0 ± 30.2	110.4 ± 33.1	114.7 ± 40.3	95.3 ± 45.4	106.7 ± 33.6
HDL	48.5 ± 10.1	52.0 ± 9.1	47.0 ± 11.8	46.1 ± 9.5	50.2 ± 22.8	48.2 ± 12.1
VLDL	42.8 ± 23.6	24.6 ± 16.2	38.1 ± 24.6	23.4 ± 11.7	46.9 ± 21.3	28.88 ± 16.7

Values (mg/dl) are expressed as mean ± SD

Table 6: Effect on lipid profile in diabetic groups consuming RBSO and SO.

	RBSO		Soybean oil	
	0 week	12 weeks	0 week	12 weeks
TC	199.1 ± 51.2	193.0 ± 51.0	199.5 ± 58.8	192.3 ± 46.1
TG	200.4 ± 112.1	145.1 ± 83.5	146.0 ± 65.3	147.5 ± 67.4
LDL	95.3 ± 45.4	106.7 ± 33.6	97.8 ± 35.7	107.3 ± 29.5
HDL	50.2 ± 22.8	48.2 ± 12.1	49.0 ± 16.4	46.2 ± 10.7
VLDL	46.9 ± 21.3	28.9 ± 16.7	49.1 ± 20.8	28.5 ± 12.7

Values (mg/dl) are expressed as mean ± SD

Table 7: Effect on lipid profile in diabetic groups consuming RBSO and SO before crossover.

	RBSO (n=12)		Soybean oil (n=12)	
	0 week	**12 weeks**	**0 week**	**12 weeks**
TC	195.3 ± 60.7	181.8 ± 38.5	188.8 ± 49.8	175.5 ± 37.4
TG	192.8 ± 124.4	174.7 ± 101.4	130.5 ± 61.3	117.0 ± 44.8
LDL	87.1 ± 56.9	97.4 ± 29.4	97.7 ± 32.0	98.9 ± 21.7
HDL	55.8 ± 31.1	44.6 ± 9.1	48.0 ± 13.4	47.3 ± 10.1
VLDL	50.9 ± 20.5	34.8 ± 20.2	43.3 ± 14.0	23.9 ± 8.6

Values (mg/dl) are expressed as mean ± SD, * (p=0.005).

Lipid profile after crossover of the oils

No significant change in total cholesterol levels, triglyceride levels, LDL Cholesterols levels, VLDL cholesterol levels and HDL Cholesterol levels were observed after the crossover of oils consumption as compared to respective baseline values and between the groups (Tables 7 and 8).

Table 8: Effect on lipid profile in diabetic groups consuming RBSO and SO after crossover.

	RBSO (n=12)		Soybean oil (n=12)	
	0 week	12 weeks	0 week	12 weeks
TC	161.7 ± 22.3	191.3 ± 45.3	176.4 ± 32.8	199.3 ± 56.0
TG	126.2 ± 48.2	104.7 ± 31.9	164.2 ± 74.4	165.4 ± 88.7
LDL	80.0 ± 21.7	91.0 ± 23.2	87.1 ± 33.1	96.4 ± 55.6
HDL	44.2 ± 14.6	45.1 ± 10.0	43.3 ± 7.3	45.8 ± 11.6
VLDL	26.4 ± 9.8	24.3 ± 12.4	32.8 ± 14.9	34.1 ± 20.6

Values (mg/dl) are expressed as mean ± SD, *(p=0.005).

Safety evaluation

Liver function tests

Average activity of liver enzymes ALT, AST, ALP decreased on consumption of RBSO in all the three groups i.e. nondiabetic, prediabetic and diabetic group. Alkaline phosphatase decreased very significantly in nondiabetic (p=0.009) and diabetic groups (p=0.001). In the prediabetic group Alanine amino transferase (ALT) activity decreased significantly (p-0.003) as compared to its baseline value. No significant change in ASL, ALT activity was observed in diabetic subjects consuming soybean oil. Mild decrease in Alkaline phosphatase activity was observed (p=0.01) in SO consuming diabetic group (Tables 9 and 10).

Table 9: Effect on Liver function tests.

	Non Diabetic		Pre Diabetic		Diabetic	
	0 week	12 weeks	0 week	12 weeks	0 week	12 weeks
AST	27.4 ± 15.0	22.21 ± 7.5	28.4 ± 11.3	29.7 ± 44.12	29.1 ± 14.7	24.9 ± 8.2
ALT	39.5 ± 42.2	30.0 ± 21.8	44.1 ± 24.8	34.0 ± 16.7 (p=0.003)	45.5 ± 25.4	36.7 ± 13.4
ALP	145.5 ± 62.7	119.4 ± 33.0 (p=0.009)	116.8 ± 28.9	114.4 ± 30.6	167.3 ± 75.9	123.2 ± 32.4 (p=0.001)
BILIRUBIN	0.64 ± 0.39	0.82 ± 0.092	0.75 ± 0.33	0.7 ± 0.29	1.06 ± 1.32	0.77 ± 0.41
Values (mg/dl) are expressed as mean ± SD						

Table 10: Effect on Liver function tests in diabetic groups consuming RBSO and SO.

	RBSO		Soybean oil	
	0 week	12 weeks	0 week	12 weeks
AST	29.1 ± 14.7	24.9 ± 8.2	24.7 ± 9.5	25.1 ± 12.7
ALT	45.5 ± 25.4	36.7 ± 13.4	34.0 ± 17.3	343.0 ± 18.9
ALP	167.3 ± 75.9	123.3 ± 32.4	167.0 ± 69.9	131.2 ± 28.7 (p=0.01)
BILIRUBIN	1.06 ± 1.32	0.77 ± 0.41	0.68 ± 0.28	0.74 ± 0.41
Values (mg/dl) are expressed as mean ± SD				

Renal function tests

A very significant decrease in serum creatinine levels were observed in non-diabetic (p=0.001), Pre-Diabetic (p=0.001) and diabetic group (p=0.001) as compared to respective baseline value in subjects consuming RBSO. A significant decrease in serum urea levels (p=0.009) and serum uric acid levels (p=0.001) were also observed in prediabetic subjects consuming RBSO.

No significant change in serum urea levels and serum creatinine levels were observed in diabetic subjects consuming SO. A significant increase (p=0.039) was observed in serum uric acid levels in diabetic subjects consuming SO (Tables 11 and 12).

Table 11: Effect on renal function.

	Non-diabetic		Pre-diabetic		Diabetic	
	0 week	12 weeks	0 week	12 weeks	0 week	12 weeks
Urea	18.7 ± 6.2	18.9 ± .7	20.0 ± 5.6	17.2 ± 4.9	22.3 ± 8.7	20.0 ±6.3
Creatinine	1.0 ± 0.2	1.0 ± 0.2	1.1 ± 0.2	1.0 ± 0.2	1.1 ± 0.2	1.1 ± 0.2
Uric acid	5.3 ± 1.9	5.3 ± 1.8	6.5 ± 2.0	5.3 ± 1.9	6.1 ± 1.8	5.5 ± 2.4
Values (mg/dl) are expressed as mean ± SD						

Table 12: Effect on kidney function tests in diabetic groups consuming RBSO and Soybean oil.

	RBSO		Soybean Oil	
	0 week	12 weeks	0 week	12 weeks
Urea	22.3 ± 8.7	20.0 ± 6.3	22.4 ± 7.3	21.7 ± 8.0
Creatinine	1.13 ± 0.2	1.1 ± 0.2	1.2 ± 0.3	1.1 ± 1.3
Uric acid	6.1 ± 1.8	5.5 ± 2.4	5.9 ± 1.0	6.2 ± 2.0
Values (mg/dl) are expressed as mean ± SD				

Table 13: Effect on haematological parameters is RBSO group.

	Non Diabetic		Prediabetic		Diabetic	
	0 week	12 weeks	0 week	12 weeks	0 week	12 weeks
Hb%	12.60 ± 1.72	12.49 ± 1.73	13.29 ± 1.61	13.51 ± 1.65	12.93 ± 1.47	12.95 ± 1.72
TLC	7.43 ± 2.14	7.90 ± 1.89	7.67 ± 1.86	7.54 ± 1.37	8.08 ± 1.96	7.62 ± 2.02
Neutrophils	60.77 ± 8.29	61.27 ± 6.34	62.63 ± 8.54	60.87 ± 6.38	59.31 ± 6.29	59.02 ± 7.27
Lymphocytes	32.42 ± 7.83	32.27 ± 6.52	30.58 ± 7.70	30.73 ± 4.91	33.08 ± 5.17	33.47 ± 5.46
Monocytes	2.25 ± 1.03	2.40 ± 1.19	2.04 ± 0.99	2.90 ± 0.88	2.45 ± 1.10	2.24 ± 1.33
Eosinophils	4.08 ± 2.46	3.64 ± 2.19	4.68 ± 4.71	5.03 ± 4.96	4.33 ± 3.73	5.06 ± 3.41
Basophils	0.49 ± 0.29	0.40 ± 0.24	0.33 ± 0.23	0.48 ± 0.33	0.55 ± 0.46	0.43 ± 0.29
Platelets	249.31 ± 55.42	254.76 ± 63.25	233.25 ± 68.83	256.39 ± 68.55	262.23 ± 113.69	282.88 ± 102.46
Values (mg/dl) are expressed as mean ± SD						

Table 14: Effect on hemogram in diabetic groups SO.

	Soybean Oil	
	0 week	12 weeks
Hb%	13.15 ± 1.400	13.04 ± 1.11
TLC	9.12 ± 2.61	8.53 ± 2.58
Neutrophils	62.84 ± 9.25	62.83 ± 5.87
Lymphocytes	30.70 ± 7.89	30.86 ± 4.66
Monocytes	2.80 ± 1.73	2.25 ± 1.098
Eosinophils	3.25 ± 1.81	3.65 ± 2.28
Basophils	0.44 ± 0.23	0.38 ± 0.26
Platelets	262.04 ± 105.39	277.44 ± 70.18
Values (mg/dl) are expressed as mean ± SD		

Hemogram

No significant Change in hematological parameter was observed in all the groups (Tables 13 and 14).

DISCUSSION

Nutritional habits are rapidly changing across the globe leading to increased incidence of obesity, the metabolic syndrome, and type 2 diabetes mellitus (T2DM) [10]. Fast foods are being choice of many, so calorie-dense foods containing refined carbohydrates, fats, red meats, and low fiber are readily available and their consumption has increased drastically. Many reports indicate an increase in the supply of animal fats and increased intake of Saturated Fatty Acid (SFAs) (obtained from coconut oil, palm oil, and clarified butter) in many developing countries, particularly in South Asia and South-East Asia [11].

The present study was a randomized, double blind, comparative study and it shows that consumption of Rice bran Oil (80% physically refined rice bran oil) blended with 20% sesame oil (RBSO) resulted in decrease in fasting blood sugar levels. In prediabetic group the decrease was 5.48% and in diabetic group the decrease was 19.77%. In diabetic group the decrease was statistically significant. Similarly decrease in post prandial blood sugar levels and Glycatedhaemoglobin levels were observed in prediabetic and diabetic groups.

The decrease in FBS levels, RBSO was greater and significant as compared to soyabean oil group. Similarly the decrease in PPBS was 18% in RBSO group where as it 7.6% in the soyabean oil group. The RBSO group showed 9.5% decrease in HbA1c levels as compared to its baseline value, whereas 4.5% increase in soyabean oil was observed.

Posuwanet al. evaluated the effect of Riceberry bran oil (RBBO) supplementation on oxidative stress and organ histology in streptozotocin-induced diabetic rats fed a High Fat (HF) diet. They reported that after 12 weeks, RBBO significantly decreased malondialdehyde levels and restored activities of superoxide dismutase, catalase, glutathione peroxidase alongwith coenzyme Q(10) levels and oxygen radical absorbance capacity in diabetic rats. RBBO additionally improved the regenerative changes of the pancreas, kidneys, heart and liver. They suggested RBO consumption can be of benefit to diabetic patients [12]. Cheng et al., reported that gamma origzanol, the antioxidant component of Rice bran oil increased insulin sensitivity in T2DM rats [13].

In the present study, 12 weeks of consumption of RBSO as cooking mediumwas associated with improvement in glycemic control as well as lipid profile in diabetic patients. Rice bran oil is rich in antioxidant like oryzanol and vitamin E. The combination has synergistic effect on improvement of FBS and HbA1c levels. Farajbakhsh et al. studied the effects of sesame oil enriched with vitamin E (vit E), sesame oil alone and sunflower oil on lipid profile, Fasting Blood Glucose (FBG), malondialdehyde (MDA), High-sensitivity C-reactive Protein (Hs-CRP), Homeostatic Model Assessment (HOMA-IR), and Blood Pressure (BP) in patients with Metabolic Syndrome (MetS). They reported that the sesame oil enriched with vit E group significant reduced serum Total Cholesterol (TC), triglycerides (TG), FBG, HOMA-IR, MDA, hs-CRP, High-Density Lipoprotein (HDL-C) systolic and diastolic BP [14]. Sankar et al. reported that sesame oil and glibenclamide alone, combination therapy showed an improved anti-hyperglycemic effect with 36% reduction of glucose (P<0.001 'vs' before treatment, P<0.01 ' vs ' sesame oil monotherapy, P<0.05 vsglibenclamidemonotherapy) and 43% reduction of HbA(1c) (P<.001 ' vs ' before treatment, P<0.01 ' vs ' sesame oil monotherapy, P<0.05 'vs'glibenclamidemonotherapy) at the end point [9]. Mohamed et al. investigated the molecular effects of rice bran oil (RBO) on the gene expression of insulin receptor (IR), insulin receptor substrate-1 (IRS-1), glucose transporters-4 and 5 (GLUT-4 and 5) in insulin-resistant rats induced by High Fructose diet (HFD). They concluded that the supplementation of RBO alleviated this insulin signaling blockade by improving the function of IR and IRS-1 by promoting PI3K/Akt phosphorylation and activating GLUT4 expression [15]. Asalamet al. reported that consumption of sesame oil significantly improved blood glucose, cardiac, liver, and kidney functions in adolescent, male Sprague-Dawley rats with STZ-induced diabetes [16].

In the present study, a significant decrease in serum triglyceride levels and VLDL levels were observed on consumption of RBSO. The decrease in triglyceride levels in prediabetic (p=0.005) and diabetic group (p=0.008) consuming RBSO was statistically significant. In the pre-diabetic group, serum triglyceride level was decreased by 31.38% and in diabetic group average triglyceride levels decreases by 27.6% as compared to the respective baseline levels. The decrease in VLDL cholesterol levels was significant (p=0.001) in diabetic group on RBSO. Diabetic subjects on SO, no change in triglyceride levels were observed. Yalagalaet al. studied effect of RBO and Sesame oil on imflammaotry markers and reported that an upregulation of Sterol Regulatory Element-Binding Protein (SREBP)-2 and peroxisome proliferator-activated receptor gamma (PPAR γ) and downregulation of nuclear factor-kappa B (NF-κB) p65 resulting in hypolipidemic and anti-inflammatory properties of rice bran oil and sesame oil [17]. Clinically, consumption of 50 g RBO daily for 4 weeks by hypercholesterolemia male subjects significantly decreased total serum cholesterol concentrations, and consumption of 75 ml RBO daily for 50 d by healthy subjects reduced total serum cholesterol concentrations. Moreover, total plasma cholesterol concentrations were significantly lower in hyperlipidemic patients who used RBO as cooking oil for 3 month than in those who used sunflower oil as cooking oil for 3 month [18].

The results of current study correlated very well with earlier published reports of Devarajan et al., who evaluated effect of consumption of blend of rice bran oil and sesame oil in type II diabetic subjects and reported that the 20% cold pressed unrefined sesame oil and 80% physically refined rice bran oil lowered blood glucose levels and improved lipid profile in type II diabetic patients [19].

The constituents of rice bran oil and sesame oil have been studied for their anti-diabetic properties and there are number of reports those confirm their anti-hyperglycemic activities. Ghatak et al., reported that oryzanol effectively ameliorate the

oxidative stress induced by streptozotacin in rats and caused decrease in blood glucose levels. An imbalance between free radical production and antioxidant defenses leads to the generation of oxidative stress resulting in deregulation of cellular functions, which can be alleviated by potent antioxidant products. Ghatak et al. reported strong antioxidant potential of oryzanol and its anti-hyperglycemic activity in streptozotacin induced diabetic rats [20].

Sankar et al. reported that Sesame oil exhibits synergistic effect with anti-diabetic medication in patients with type 2 diabetes mellitus. It is reported that activities of enzymatic and non-enzymatic antioxidants improved significantly in patients treated with sesame oil and its combination with glibenclamide. Monounsaturated-rich diets are known to be capable of reducing blood glucose levels by delaying glucose absorption. Sesame oil is highly unsaturated oil, thus the very nature of the oil itself may be able to regulate glucose levels. Presence of, unsaturated fatty acids in the blend of rice bran oil and sesame oil, oryzanol and tocopherols along with sesame lignans contribute in lowering triglyceride and VLDL levels [19].

In addition to improving blood sugar and lipid levels, in the current study we also observed that the consumption blend of of rice bran oil+sesame oil decreased urea, creatinine and uric acid levels in prediabetic subjects and diabetic patients. This indicates improvement in kidney functions in prediabetic and diabetic patients. As it is well known that many of the diabetic patients may suffer from renal abnormalities/dysfunction due oxidative damage. Many published reports suggest constituents of sesame oil and rice bran oil possess nephron-protective activities.

CONCLUSION

Twelve week of regular use of RBSO (blended of 80% rice bran oil with 20% sesame oil) as cooking medium was safe well tolerated in routine use and exerted beneficial effect in terms of improved glycemic control and lipid profile significantly in the diabetic patients and also to certain extent in pre-diabetic subjects. The investigators however, feel a larger multicentric clinical trial supplemented with long term safety data may be necessary to establish the efficacy in a wider population range and different genetic variation.

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REFERENCES

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. diabetes care.2009;62–67.
2. Cho NH, Shaw JE,Karuranga S, Huang Y, da Rocha Fernandes JD (2018). IDF Diabetes atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res ClinPract. 2018;38:271-281.
3. EinarsonTR, Acs A, Ludwig C, Panton UH. Prevalence of cardiovascular disease in type 2 diabetes: A systematic literature review of scientific evidence from across the world in 2007–2017. CardiovascDiabetol. 2018;17:83.
4. UpadhyayRP.An Overview of the burden of non-communicable diseases in india. Iran J Public Health. 2012;41(3): 1–8.
5. Patel PS, Sharp SJ, Jansen E, Luben RN, Khaw KT. Fatty acids measured in plasma and erythrocyte-membrane phospholipids and derived by food-frequency questionnaire and the risk of new-onset type 2 diabetes: A pilot study in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Norfolk cohort. Am J ClinNutr. 2010;92(5):1214-22.
6. Risérus U, Willett WC, Hu FB. Dietary fats and prevention of type 2 diabetes. Prog Lipid Res. 2009; 48:44-51.
7. Mehta BV, Mogal YM, Chakraborty SS. SEA HANDBOOK: Unique reference book on Indian vegetable oil industry & trade. 2014; 1151-1156.
8. Iqbal S, Bhanger MI, Anwar F. Antioxidant properties and components of some commercially available varieties of rice bran in Pakistan. Food Chem. 2005;93: 265-272.
9. Sankar D, Ali A, Sambandam G, Rao R. Sesame oil exhibits synergistic effect with anti-diabetic medication in patients with type 2 diabetes mellitus. ClinNutr. 2011;30(3):351-358.
10. Sami W,Ansari T, Butt NS, Ab Hamid MR. Effect of diet on type 2 diabetes mellitus: A review. Int J Health Sci. 2017;11(2): 65–71.
11. Misra A, Singhal N, Khurana L. Obesity, the metabolic syndrome, and type 2 diabetes in developing countries: role of dietary fats and oils. J Am CollNutr. 2010;29(3): 289-301.
12. Posuwan J, Prangthip P, Leardkamolkarn V, Yamborisut U, Surasiang R. Long-term supplementation of high pigmented rice bran oil (Oryza sativa L.) on amelioration of oxidative stress and histological changes in streptozotocin-induced diabetic rats fed a high fat diet; Riceberry bran oil. Food Chem. 2013;138(1): 501-508.
13. Cheng HH, Ma CY, Chou TW, Chen YY, Lai MH. Gamma-oryzanol ameliorates insulin resistance and hyperlipidemia in rats with streptozotocin/nicotinamide-induced type 2 diabetes. Int J VitamNutr Res. 2010;80(1):45-53.
14. Farajbakhsh A, Mazloomi SM, Mazidi M, Rezaie P, Akbarzadeh M. Sesame oil and vitamin E co-administration may improve cardiometabolic risk factors in patients with metabolic syndrome: a randomized clinical trial. Eur J ClinNutr. 2019;73(10):1403-1411.
15. Mohamed MA, Ahmed MA, AbdElbast SA, Ali NA. Rice bran oil ameliorates hepatic insulin resistance by improving insulin signaling in fructose fed-rats. J Diabetes MetabDisord. 2019;18(1): 89-97.
16. Aslam F, Iqbal S, Nasir M, Anjum AA, Swan P. Evaluation of white sesame seed oil on glucose control and biomarkers of hepatic, cardiac, and renal functions in male sprague-dawley rats with chemically induced diabetes. J Med Food. 2017;20(5): 448–457.
17. Yalagala PC, Sugasini D, Ramaprasad TR, Lokesh BR. Minor constituents in rice bran oil and sesame oil play a significant role in modulating lipid homeostasis and inflammatory markers in rats. J Med Food. 2017;20 (7): 709-719.
18. Lai MH, Chen YT, Chen YY, Chang JH, Cheng HH. Effects of rice bran oil on the blood lipids profiles and insulin resistance in type 2 diabetes patients. J ClinBiochemNutr. 2012;51(1): 15–18.
19. Devarajan S, Chatterjee B, Urata H, Zhang B, Ali A.A Blend of sesame and rice bran oils lowers hyperglycemia and improves the lipids. Am J Med. 2016;129(7):731-739.

20. Ghatak SB, Panchal SS. Anti-diabetic activity of oryzanol and its relationship with the anti-oxidant property. Int J Diabetes Develop. 2012;32:185–192.