

Project Report

**Effect of oyster mushroom (pleurotus spp.) on
glycemic control, lipid profile and diabetic quality of
life in type 2 diabetic patients: a double blind placebo
controlled study**

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Project Title: Effect of oyster mushroom (pleurotus spp.) on glycemic control, lipid profile and diabetic quality of life in type 2 diabetic patients. Double blind placebo controlled study

Aims & Objectives:- The aim of the study was to evaluate the efficacy of oyster mushroom (pleurotus spp.) on glycemic control, lipid profile and diabetic quality of life in type-2 diabetic patients.

Material & Method:-

Study design: A randomized double blind placebo controlled study.

A total of 150 type-2 newly onset diabetic patients were recruited. After 1 month stabilization period by diet and exercise 120 patients were randomly selected for this study. These patients were divided into three groups. Group-1 received biscuits of type A, group 2 received biscuits of type B and group 3 received biscuits of type C. Biscuits were given by dietician. She was not aware about the nature of the biscuits. All the three groups were also given conventional treatment i.e. diet, exercise for 3 months. Anthropometric parameters, fasting blood sugar and blood pressure were recorded weekly and HbA_{1c}, lipid profile, diabetic quality of life questionnaire were performed initially as well as after 3 months. After 3 months decoding was done by statistician and it was concluded that type A biscuits were Ajwain biscuits, type B were Ajwain + Mushroom biscuits and type C were Mushroom biscuits.

Results: After 3 months period blood sugar was found reduced in ajwain + mushroom group (225.41±3.35 to 113.83±4.03; p<0.005) as also in mushroom group (212.9±4.29 to 112±1.37; p<0.005), Systolic blood pressure reduced in both groups ajwain + mushroom (130.75±2.10 to 121.50±1.16; p<0.05) and in mushroom group (126.8±1.73 to 121.65±1.3; p<0.05), Diastolic blood pressure reduced in [ajwain + mushroom group (85.00±1.31 to 79.70±0.70; p<0.05) and in mushroom group (82.00±0.96 to 79.95±0.79; p<0.05)]. There was also significant effect on glycemic control (HbA_{1c}) in both groups [ajwain + mushroom group (8.47±0.17 to 7.27±0.14; p<0.02) mushroom group (8.00±0.13 to 6.99±0.12; p<0.05)], there was significant reduction in lipid profile i.e. total cholesterol ajwain + mushroom group (190.69±4.39 to 166.83±2.47; p<0.001) and mushroom group (186.77±3.43 to 157.39±2.32; p<0.05), HDL in ajwain + mushroom group (40.42±0.92 to 45.40±0.91; p<0.005) and in mushroom group (45.81±2.03 to 49.30±1.47; p<0.05), LDL in ajwain + mushroom group (110.05±2.55 to 98.21±1.38; p<0.05) and mushroom group (103.04±3.41 to 96.99±3.30; p<0.05), VLDL in ajwain + mushroom group (42.62±2.03 to 28.62±1.26; p<0.05) and in mushroom group (42.42±2.35 to 31.40±1.81; p<0.05), serum triglyceride in ajwain + mushroom group (213.93±14.24 to 144.73±7.01; p<0.05) and in mushroom group (210.71±12.49 to 157.41±7.79; p<0.02), Diabetes quality of life also improved significantly but there was no significant change in BMI & WAIST/HIP ratio. Positive changes regarding all parameters were observed in mushroom and mushroom + ajwain group. When improvement was compared between both of these groups, it was observed that additional supplementation of ajwain excreted no extra effect.

Conclusion: Oyster mushroom (pleurotus spp.) consumption appears to be effective in controlling glycemic control, lipid profile and diabetic quality of life and acceptability of mushroom biscuits were excellent..

Statistical Method: Using ANOVA, confidential limit and correlation.

Keywords: Oyster Mushroom, Diabetes, Glycemic control

2. Background:

Health is a birth right of every individual. The increasing evidence that the dietary habits of people are important determinants of health. Proper dietary substances can either protect person from chronic diseases like: coronary heart disease, cancer, obesity and diabetes mellitus. Diabetes mellitus is an universal health problem affecting human society at all stages of development¹. Diabetes mellitus is relatively a common disorder in India, it has been defined as a genetically and clinically heterogeneous group of disorders. It is mainly caused by degeneration and inactivations of the β cells of islets of langerhans. There is serious defect of carbohydrate, fat and protein metabolism in this disorder².

There are two major types of diabetes. Type 1 diabetes (IDDM) known as insulin dependent diabetes mellitus, which is usually diagnosed in childhood. In this case body makes little or no insulin and daily injections of insulin are required to live.

Type 2 diabetes, known as non-insulin dependent diabetes mellitus (NIDDM) which is more common in about 90% of all diabetes cases and usually occurs in adulthood. In this type of diabetes diet, exercise or oral antidiabetic drugs may be enough to control the raised blood sugar³.

Diabetes is one of the condition, which is managed by proper dietary management. Regardless of strict dietary principles, diets need change in their routine diet pattern⁴. Recent report have shown that diet plays important role in treatment of diabetes. Diet is the corner stone in the management of diabetic mellitus. In recent years several studies indicates that low glycemic index of food have a significant influence on blood glucose level.

Traditional medicine are very useful for treating any kind of health problems. Mushroom is one of them. It is used as anti diabetic drug since ancient time. Mushroom are edible fungi conformed to have a definite role in human health and nutrition. Mushroom used as food is probably as old as civilization itself. The nutritive value of mushroom was recognized recently. Mushrooms are richer in protein as compared to cereals, pulses, fruits and vegetables on dry weight⁵. Due to its low calorific value mushrooms can form an excellent slimming diet. As fresh mushroom contains less fat they can be consumed by patients having hyperlipidemia (high blood lipid)⁶. They are completely devoid of starch and hence can constitute a good item in the diet of diabetic patients. Edible fungi also have medicinal value. They produce secondary metabolites which possess various therapeutic properties.

Mushrooms also contain ample minerals such as Ca, P, Fe, K and Cu which contribute good medico – nutritional and digestibility values. They are known to prevent disorders of diabetes, obesity, heart disease, hyperacidity, constipation, cancer, blood pressure and hypertension⁷. Mushroom have an important role to play in diabetes. Due to presence of polysaccharides in mushroom they posses properties of low glycemic index, lack sugar and starch.

“Hence they are known to be delight of the diabetic”

Mushrooms are extremely useful in the prevention of diabetes mellitus as they are low in fat and calories and sugar reducing property is also present. Therefore the present study was undertaken with the objective of incorporating mushroom into Indian food products so that diabetic patients may get low fat, low calorie and sugar free products.

In the era of healthy eating by cutting down the calories, saturated fat and cholesterol, mushrooms were bound to attract the attention. Mushrooms have long been considered especially to have medicinal values. Early herbalists recommended mushrooms more effective due to their medicinal value than nutritional value. Due to unique chemical composition mushrooms are suitable to the specific groups suffering with some disorders.

As a low caloric – high protein diet with almost no starch and sugars mushrooms are the delight of the diabetes⁸. Due to high K, Na ratio few calories and low fat, mushrooms are the choice of the deficient for those with obesity, hypertension and other atherosclerosis. Extracts and powders of these mushrooms in the form of capsules or sugar coated tablets are being marketed⁹. Active principles are said to be immune stimulating polysaccharides strengthening health and immunity.

According to researcher keiko pubo (mushroom biology and mushroom products) have investigated in maitake called fraction which may benefit people with non-insulin dependent diabetes mellitus (NIDDM)⁴.

3. Drug Profile and preclinical data:

a) i. Common Name: Oyster Mushroom
Botanical name: Pleurotus Ostreatus
Quality standard: 100% organic

ii. Common Name: Ajwain
Botanical name: Trachyspermum copticum
Quality standard: 100% organic

MUSHROOM BISCUIT COMPOSITION

INGREDIENTS	AMOUNT
Refined Flour	25gm.
Mushroom Powder	25gm.
Butter	15gm.
Sucralose (Sugar Free Tab.)	10gm.
Salt	½ tsf
Ammonium bicarbonate	a pinch
Milk	to make the dough (capp. 2T)

AJWAIN BISCUIT COMPOSITION

INGREDIENTS	AMOUNT
Refined Flour	25gm.
Ajwain seeds	½ tsf
Butter	15gm.
Sucralose (Sugar Free Tab.)	10gm.
Salt	½ tsf
Ammonium bicarbonate	a pinch
Milk	to make the dough (capp. 2T)

MUSHROOM + AJWAIN BISCUIT COMPOSITION

INGREDIENTS	AMOUNT
Refined Flour	25gm.
Mushroom Powder	25gm.
Butter	15gm.
Sucralose (Sugar Free Tab.)	10gm.
Salt	½ tsf
Ajwain seeds	½ tsf
Ammonium bicarbonate	a pinch
Milk	to make the dough (capp. 2T)

b) Pharmacognostical aspects were not studied.

c) METHOD OF MUSHROOM BISCUIT PREPARATION

1. Sieve the flour, mix mushroom powder, salt and ammonium bicarbonate together
2. Add cream and butter
3. Add little milk to the creamed mixture
4. If the mixture shows signs of curdling, a little amount of flour may be added
5. Add standardized mushroom powder and mix to make a soft dough
6. Roll dough on a floured board into ¼" thickness, cut into biscuits with cutter
7. Place on a greased baking tray and bake in a moderate oven (350°F) till golden brown in colour
8. Cool on a grill before serving

METHOD OF OTHER BISCUIT PREPARATION

1. In Ajwain biscuits, Ajwain seeds were added in place of Mushroom powder.
2. In Mushroom + Ajwain biscuits, Ajwain seeds were added along with Mushroom powder.

d) Standardization of Oyster Mushroom

Proximate:	
Moisture:	Moisture analysis by moisture balance.
Protein:	Micro Kjel Dhal method
Fat:	Foxlet method (foxlet apparatus)
Fibre:	Fibre estimation by Fibra plus
Ash:	Charring process in Mussle furnace
Carbohydrates:	Total difference method (100- Protein + Fat + Fibre + Ash)
Energy:	(Fat × 9)+(Protein × 4)+(Carbohydrate × 4)
Minerals:	Atomic Absorption Spectrophotometry (AAS)
Vitamins:	Titrimetry Method

- e) Mushroom is a natural herbal product, easily acceptable by human beings. Only clinical and biochemical parameters studies for safety purpose were seen in all groups.
- f) It was not required in our project.

4. Material and Methods:

- a) **Aims & Objectives:** The aim of the study was to evaluate the efficacy of oyster mushroom (pleurotus spp.) on glycemic control, lipid profile and diabetic quality of life in type-2 diabetic patients.
- b) **Centre of the study:** Diabetes Care & Research Centre, S.P. Medical College, Bikaner.
- c) **Sample size and methods:**
No. of cases: 120
No. of groups: 3
No. of patients in each group: 40
Type of study: Double blind
Level of study: OPD
Drug dosage and other schedules: 4 biscuits daily contents 25gm mushroom.
- d) **Source of procurement of drug:** Aryan Mushrooms and Bio Fuels
Works: "Uday Villa" Noorpur Road, Nehtaur,
Dist. Bijnor, UP.

e) Inclusion criteria:

- Subject with a diagnosis of type 2 diabetes mellitus, according to American Diabetes Association guidelines.
- Fasting blood sugar greater than equals to 126 but less than equals to 250 mg/dl.
- Written consent showing willingness to participate in the study.

f) Exclusion Criteria: Patients suffering from kidney, liver disease, arthritis, pulmonary tuberculosis, malabsorption, alcoholism were excluded from the study.

g) Criteria for withdrawal: Patients with compliance below 80% were planned to be withdrawn. No patient was withdrawn due to good compliance.

h) Routine examination and assessment: History, clinical examination were done for suitable inclusion criteria. Dietary survey by 24 hour recall system was done. Anthropometric parameters, fasting blood sugar and blood pressure were recorded weekly and HbA_{1c}, lipid profile, diabetic quality of life questionnaire were performed initially as well as after 3 months.

i) period of study: One year

j) Follow up: no follow up was planned

k) Criteria for assessment of result of treatment: Glycemic control, lipid profile and diabetes quality of life.

l) Statistical analysis: ANOVA

m) Trial monitoring and data analysis: It was monitored by Principal Investigator and data analysis was done by Statistician.

n) Ethical review: Approval copy of ethical committee is enclosed.

Model Protocol:

Study population: A total of 150 type 2 newly onset diabetic patients were recruited from the outpatient department of Diabetes Care & Research Centre, S.P. Medical College, Bikaner.

The patients were advised to follow a strict diet and exercise for one month. During this period, frequent self monitoring of blood sugar were done to maintain euglycemic level. After one month of stabilization period 120 patients were selected out of 150 patients having blood sugar level 126-250 mg/dl. These 120 patients were randomly divided into three groups: Group 1 (n=40), Group 2 (n=40) and Group 3 (n=40). Group-1 received biscuits of type A, group 2 received biscuits of type B and group 3 received biscuits of type C. Biscuits were given by dietician, she was not aware about the nature of biscuits.

Standardization was done of the Oyster Mushroom before clinical trials. Proximate composition of the Pleurotus sajor-ciju is

	Mois.	Protein	Fat	CHO	Fibre	Ash	Calories
Pleurotus sajor-ciju	90.2	2.5	0.2	5.2	1.3	0.6	35

Study design: It was a randomized double blind, placebo controlled study. History, clinical examination were done for suitable inclusion criteria. Dietary survey by 24 hour recall system was done. Anthropometric parameters, fasting blood sugar and blood pressure were recorded weekly and HbA_{1c}, lipid profile, diabetic quality of life questionnaire⁸⁻⁹ were performed initially as well as after 3 months. The approval was taken before hand from Ethics committee, S.P.Medical College, Bikaner.

After 3 months decoding was done by statistician it was concluded that type A biscuits were Ajwain biscuit, type B were Ajwain + Mushroom biscuit and type C were Mushroom biscuits. Patients were closely observed for any un-toward effect during the study period.

Inclusion criteria:

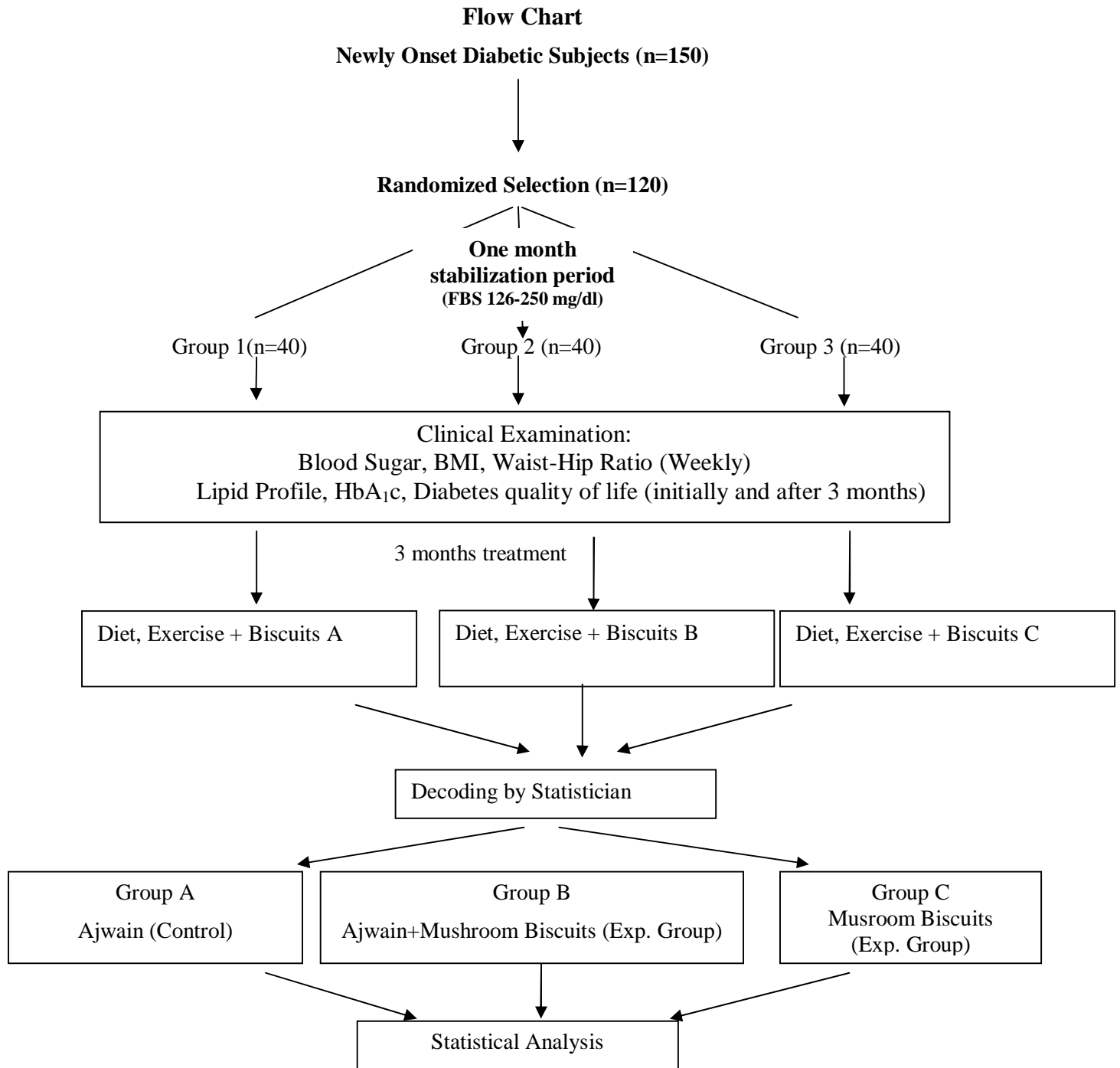
- Subject with a diagnosis of type 2 diabetes mellitus, according to American Diabetes Association guidelines.
- Fasting blood sugar greater than equals to 126 but less than equals to 250 mg/dl.
- Written consent showing willingness to participate in the study.

Exclusion Criteria: Patients suffering from kidney, liver disease, arthritis, pulmonary tuberculosis, malabsorption, alcoholism were excluded from the study.

Anthropometry:

Anthropometric measurements were taken viz height in cm and weight in Kg with the use of digital machine accessorized with a movable headboard. Participants were shoeless and wore light clothing. Waist Hip ratio was estimated through measuring tape. Waist circumference was measured at the mid point between the lower border of the rib cage and the iliac crest. Hip circumference was measured at the level of maximum prominence of the buttocks parallel to the floor / the horizontal girth measured round the buttocks at the level of greatest lateral trochanteric projectors.

- Blood pressure: by sphygmomanometer
- Fasting blood sugar: by glucose oxidase method
- Lipid profile: by auto analyzer
- HbA_{1c}: by DS5 Drew Scientific machine (ion exchange chromatography)
- Diabetes quality of life questionnaire was assessed every month



Statistical Analysis:

In this randomized, double blind placebo study, data were presented as means ± SEM. Comparisons between baseline characteristics of each group were made by using ANOVA, confidential limit and correlation tests. At p value <0.05, differences were considered significant.

Proforma: Enclosed

5. Results:

The demographic and clinical profiles of three groups (ajwain, ajwain + mushroom and mushroom) were studied for different variables in the beginning of the study and there was no significant difference in baseline characteristics (Table 1).

After 3 months period the blood sugar was found reduced in ajwain + mushroom group as well as in mushroom group [(225.41±3.35 to 113.83±4.03; p<0.005) and (212.9±4.29 to 112±1.37; p<0.005)], Systolic blood pressure was also reduced in both the groups [ajwain + mushroom (130.75±2.10 to 121.50±1.16; p<0.05) and in mushroom group (126.8±1.73 to 121.65±1.3; p<0.05)], Diastolic blood pressure reduced in [ajwain + mushroom group (85.00±1.31 to 79.70±0.70; p<0.05) and in mushroom group (82.00±0.96 to 79.95±0.79; p<0.05)]. There was also significant effect on glycemic control (HbA_{1c}) in both groups [ajwain + mushroom group (8.47±0.17 to 7.27±0.14; p<0.02) mushroom group (8.00±0.13 to 6.99±0.12; p<0.05)], there was significant reduction in lipid profile i.e. total cholesterol in ajwain + mushroom group (190.69±4.39 to 166.83±2.47; p<0.001) and mushroom group (186.77±3.43 to 157.39±2.32; p<0.05), HDL in ajwain + mushroom group (40.42±0.92 to 45.40±0.91; p<0.005) and in mushroom group (45.81±2.03 to 49.30±1.47; p<0.05), LDL in ajwain + mushroom group (110.05±2.55 to 98.21±1.38; p<0.05) and mushroom group (103.04±3.41 to 96.99±3.30; p<0.05), VLDL in ajwain + mushroom group (42.62±2.03 to 28.62±1.26; p<0.05) and in mushroom group (42.42±2.35 to 31.40±1.81; p<0.05), serum triglyceride in ajwain + mushroom group (213.93±14.24 to 144.73±7.01; p<0.05) and in mushroom group (210.71±12.49 to 157.41±7.79; p<0.02), Diabetes quality of life also improved significantly. There was no significant change in BMI and Waist hip ratio (table 2,3).

6. Illustrations / Tables: 3 tables were included

Table 1
Comparison of different clinical and biochemical parameters at baseline

	Ajwain	Mushroom + Ajwain	Mushroom	Anova	Anova	
	Mean±SE 0 month	Mean±SE 0 month	Mean±SE 0 month	Ajwain V/S Mushroom + Ajwain	Ajwain V/S Mushroom	
Age	52.5±1.22	49.95±1.2	51.10±1.32	NS	NS	
Sex (M:F)	28:13	24:6	31:9	-	-	
BMI	26.87±.86	26.15±.61	26.67±0.71	<.4	<0.4	
Waist /hip Ratio	.95±.01	.94±.009	1.00±0.10	<.9	<0.8	
Fasting Blood Sugar	225.65±4.32	225.41±3.35	212.9±4.29	<.8	<.02	
Blood pressure	Systolic	131.25±1.90	130.75±2.10	126.8±1.73	<.1	<.05
	Diastolic	83.55±1.31	85.00±1.31	82.00±0.96	<.1	<0.1
HbA _{1c}	8.60±.12	8.47±.17	8.00±0.13	<.2	<0.2	
S.Cholesterol	190.22±2.68	190.69±4.39	186.77±3.43	<.1	<0.1	
HDL	44.50±.87	40.42±.92	45.81±2.03	<.1	<0.1	
VLDL	39.52±.74	42.62±2.03	42.42±2.35	<.1	<0.5	
LDL	99.39±1.35	110.05±2.55	103.04±3.41	<.1	<0.1	
S.Triglyceride	195.70±5.32	213.93±	210.71±12.49	<.1	<0.1	
DQL	Satisfactory	38.00±2.87	36.17±2.17	39.51±2.09	<.1	<0.1
	Impact	44.83±4.11	35.07±2.89	42.50±2.98	<.2	<0.1
	Worry	25.5±2.17	23.98±1.79	24.87±1.93	<.1	<0.1

BMI: Body Mass Index

HDL: High Density Lipoprotein

VLDL: Very Low Density Lipoprotein

LDL: Low Density Lipoprotein

DQL: Diabetes Quality of Life

Table 2
Effect of different treatment regimen on clinical and metabolic parametres

		Ajwain			Mushroom + Ajwain			Mushroom		
		0 month Mean±SE	3 months Mean±SE	ANOV A	0 month Mean±SE	3 months Mean±SE	ANOV A	0 month Mean±SE	3 months Mean±SE	ANOV A
Age		52.50±1.2 2		NS	49.95±1.2			51.10±1.32		NS
Sex (M:F)		27:13		-	24:16		-	31:9		-
BMI		26.87±0.8 6	27.03±0.8 9	NS	26.15±0.61	25.87±0.86	NS	26.67±0.71	26.3±0.65	NS
Waist /hip Ratio		0.95±0.01	0.94±0.01	NS	0.94±0.009	0.93±0.009	NS	1.00±0.1	0.97±0.2	NS
Fasting Blood Sugar		225.65±4. 32	310.33±3. 13	<0.005	225.41±3.3 5	113.83±4.0 32	<0.005	212.9±4.29	112±1.37	<0.005
Blood pressur e	Systolic	131.25±1. 90	138.15±2. 21	<0.05	130.75±2.1 0	121.50±1.1 6	<0.05	126.8±1.73	121.65±1. 34	<0.05
	Diastolic	83.55±1.3 1	87.55±1.1 8	<0.05	85.00±1.31	79.70±0.70	<0.05	82.00±0.96	79.95±0.7 9	<0.05
HbA _{1c}		8.60±0.12	9.98±0.14	<0.005	8.47±0.17	7.27±0.14	<0.02	8.00±0.13	6.99±0.12	<0.05
S.Cholesterol		190.22±2. 68	251.45±4. 01	<0.005	190.69±4.3 9	166.83±2.4 7	<0.001	186.77±3.4 3	157.39±2. 32	<0.05
HDL		44.50±0.8 7	36.82±0.4 6	<0.005	40.42±0.92	45.40±0.91	<0.005	45.81±2.03	49.30±1.4 7	<0.05
VLDL		39.52±0.7 4	55.2±0.69	<0.005	42.62±2.03	28.62±1.26	<0.05	42.42±2.35	31.40±1.8 1	<0.05
LDL		89.39±1.3 5	104.43±1. 18	<0.02	110.05±2.5 5	98.21±1.38	<0.05	103.04±3.4 1	96.99±3.3 0	<0.05
S.Triglyceride		195.70±5. 32	276.20±5. 32	<0.02	213.93±14. 24	144.73±7.0 1	<0.05	210.71±12. 49	157.41±7. 79	<0.02
DQL	Satisfact ory	38.00±2.8 7	32.25±2.3 6	<0.05	36.17±2.17	40.87±1.42	<0.05	39.51±2.09	42.40±0.9 8	<0.001
	Impact	44.88±4.1 1	41.5±1.22	<0.02	35.07±2.89	39.74±1.18	<0.05	42.50±2.98	44.4±1.68	<0.001
	Worry	25.5±2.17	20.33±1.9 7	<0.05	23.98±1.79	18.78±2.88	<0.005	24.87±1.93	20.85±1.8 3	<0.001

BMI: Body Mass Index
HDL: High Density Lipoprotein
VLDL: Very Low Density Lipoprotein
LDL: Low Density Lipoprotein
DQL: Diabetes Quality of Life

Table 3
Comparison of different clinical and biochemical parameters among different plans

	Ajwain	Mushroom + Ajwain	Mushroom	Anova	Anova	
	3 month Mean±SE	3 month Mean±SE	3 month Mean±SE	AjwainV/S Mushroom + Ajwain	Ajwain V/S Mushroom	
Age	52.5±1.22	49.95±1.2	51.10±1.32	-	-	
Sex (M:F)	28:13	24:6	31:9	-	-	
BMI	27.03±.89	25.91±.56	26.3±.65	<.8	<.1	
Waist /hip Ratio	.95±.01	.94±.009	0.97±.0.15	<.05*	<.02*	
Fasting Blood Sugar	310.33±3.31	113.83±4.02	112±1.37	<.001*	<.001*	
Blood pressure	Systolic	138.15±2.21	121.50±1.16	121.65±1.34	<.005*	<.001*
	Diastolic	87.55±1.18	79.70±.70	79.95±.79	<.005*	<.02*
HbA _{1c}	9.98±.14	7.27±.14	6.99±.12	<.02*	<.005*	
S.Cholesterol	251.45±4.01	166.43±2.47	157.39±2.32	<.001*	<.001*	
HDL	36.82±.46	45.42±.91	49.30±1.47	<.02*	<.001*	
VLDL	55.20±.69	28.8±1.26	31.4±1.81	<.001*	<.001*	
LDL	104.43±1.18	98.21±1.38	96.99±3.30	<.05*	<.001*	
S.Triglyceride	276.20±5.32	144.73±7.00	157.41±7.79	<.005*	<.001*	
DQL	Satisfactory	32.25±2.36	40.87±2.42	42.40±.98	<.02*	<.05*
	Impact	36.5±1.23	39.74±1.18	44.4±1.68	<.05*	<.05*
	Worry	20.33±1.97	18.78±2.40	20.85±1.83	<.2	<.2

BMI: Body Mass Index
HDL: High Density Lipoprotein
VLDL: Very Low Density Lipoprotein
LDL: Low Density Lipoprotein
DQL: Diabetes Quality of Life

7. Photographs: No Photographs

8. Discussion:

Oyster mushroom (*pleurotus* spp.) is known in the Indian traditional system of medicine for its antihyperglycemic and antihyperlipidemic potential. Mushrooms are edible fungi confirmed to have definite human health properties and nutrition. Oyster mushrooms have been demonstrated to have beneficial effect in animal and human studies individually as well as in combination.

The present study was performed to observe the effect of oyster mushroom (*pleurotus* spp.) on glycemic control, lipid profile and diabetes quality of life.

We observed that blood sugar was reduced in ajwain + mushroom group (225.41 ± 3.35 to 113.83 ± 4.03 ; $p < 0.005$) and in mushroom group (212.9 ± 4.29 to 112 ± 1.37 ; $p < 0.005$). There was also significant effect on glycemic control (HbA_{1c}) in both groups [ajwain + mushroom group (8.47 ± 0.17 to 7.27 ± 0.14 ; $p < 0.02$) mushroom group (8.00 ± 0.13 to 6.99 ± 0.12 ; $p < 0.05$)].

The significant fall in fasting blood sugar and HbA_{1c} may be attributed to the hypoglycemic potential of oyster mushroom supplement. It was reported that mushroom significantly reduced blood glucose level in diabetic subjects¹⁰. Reduction in glycated haemoglobin in streptozotocin diabetic mice after mushroom supplement was also observed¹¹.

There was significant reduction in lipid profile i.e. total cholesterol in ajwain + mushroom group (190.69 ± 4.39 to 166.83 ± 2.47 ; $p < 0.001$) and mushroom group (186.77 ± 3.43 to 157.39 ± 2.32 ; $p < 0.05$), HDL in ajwain + mushroom group (40.42 ± 0.92 to 45.40 ± 0.91 ; $p < 0.005$) and in mushroom group (45.81 ± 2.03 to 49.30 ± 1.47 ; $p < 0.05$), LDL in ajwain + mushroom group (110.05 ± 2.55 to 98.21 ± 1.38 ; $p < 0.05$) and mushroom group (103.04 ± 3.41 to 96.99 ± 3.30 ; $p < 0.05$), VLDL in ajwain + mushroom group (42.62 ± 2.03 to 28.62 ± 1.26 ; $p < 0.05$) and in mushroom group (42.42 ± 2.35 to 31.40 ± 1.81 ; $p < 0.05$), serum triglyceride in ajwain + mushroom group (213.93 ± 14.24 to 144.73 ± 7.01 ; $p < 0.05$) and in mushroom group (210.71 ± 12.49 to 157.41 ± 7.79 ; $p < 0.02$). Results of present study show that oyster mushroom lowers blood lipid levels. Reduction in total serum cholesterol, VLDL, LDL and serum triglyceride and increased serum HDL was observed in the study. It was found the cholesterol concentration was decreased in more than 40%, the lipoprotein profile was upgraded by the decrease of the cholesterol in both the low density and very low density lipoproteins in rats¹². Oyster mushroom significantly reduced serum triglyceride and serum cholesterol in diabetic subjects¹⁰. Oyster mushroom diet effectively prevented the progress of hypercholesterolaemia (decreased by 38%) and cholesterol accumulation in liver (decrease by 25%) that were induced by the cholesterol diet in rats¹³.

We observed slight reduction in mean BMI in Ajwain + mushroom group (26.15 ± 0.61 to 25.87 ± 0.86) and mushroom group (26.67 ± 0.71 to 26.3 ± 0.65) although it was not

significant statistically. We also found that W/H ratio was slightly decreased in Ajwain + mushroom group (0.94 ± 0.009 to 0.93 ± 0.009) and increased in mushroom group (0.97 ± 0.15 to 1.00 ± 0.1). This change was also not significant statistically.

Systolic blood pressure as well as diastolic blood pressure decreased significantly in ajwain + mushroom group and mushroom group. Systolic blood pressure reduced in ajwain + mushroom (130.75 ± 2.10 to 121.50 ± 1.16 ; $p < 0.05$) and in mushroom group (126.8 ± 1.73 to 121.65 ± 1.3 ; $p < 0.05$), Diastolic blood pressure reduced in [ajwain + mushroom group (85.00 ± 1.31 to 79.70 ± 0.70 ; $p < 0.05$) and in mushroom group (82.00 ± 0.96 to 79.95 ± 0.79 ; $p < 0.05$)]. Treatment of diabetic fatty rats with mushroom supplements resulted in lower systolic blood pressure and maintained body weight compared to control animals¹⁴. In another study it was concluded that the soluble fraction of maitake mushroom lowers systolic blood pressure significantly¹⁵.

We observed that there was statistically significant improvement in diabetes quality of life score, when biscuits supplement was added alongwith usual care.

Despite limited size of the study population we were able to demonstrate a significant association between mushroom supplementation and gradual reduction in hyperglycemia in type 2 diabetic subjects. Further studies are needed to verify these observations. In conclusion, the results throw light on the potential use of oyster mushroom for better glycemic control, positive effect on lipid profile and better quality of life.

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11. Diacritical Marks: No such marks have been used.

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