



**ROLE OF YAVA (BARLEY) BASED DIET AND YOGIC PRACTICES IN
MANAGEMENT OF MADHUMEHA (DIABETES MELLITUS)**

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ABSTRACT

Introduction: Diabetes mellitus (DM) is a clinical syndrome characterized by hyperglycemia, with or without glycosuria and disturbances in carbohydrate, protein and fat metabolism resulting due to the absolute or relative deficiency of Insulin secretion and/ or action. Type II diabetes (NIDDM) is commonest type of DM, accounting for almost 90% of all diabetic cases. It is one such disorder which is identified as a potential risk factor for diseases like cardiovascular diseases, metabolic syndromes and hypertension. The conventional management of DM is progressive and it is associated with many complications. The researchers and scholars are inclined towards other system of medicine to evolve newer remedial measures. In Ayurveda yava and yogic practices are mentioned as an important dietary & psychosomatic tool for care and cure of DM. Yava or Barley (*Hordeum vulgare*) is one of the most ancient cereal and best pathya in madhumeha as per Ayurveda. Yoga being a mind- body therapy has been shown to be a simple and economical therapeutic modality that may be considered as beneficial adjuvant for type 2 diabetes. Hence to establish the effect of Yava based diet and Yogic practices, study entitled “Role of Yava (barley) based diet and yogic practices in management of madhumeha (Diabetes mellitus)” was conducted. **Materials and Methods:** A total of 60 patients of Type II DM were selected based on the fulfillment of diagnostic criteria and randomly allocated into 3 groups (20 patients in each group) after getting their written informed consent. **Group A:** (Control) Ongoing Ayurvedic Treatment, **Group B:** Ongoing Ayurvedic Treatment + Yava based diet, **Group C:** Ongoing Ayurvedic Treatment + Yava based diet + Yogic practices. All the patients were advocated general pathyapathya and were assessed before treatment and at an interval of every month upto 3 months. **Results and Conclusion:** On intra-group comparison all the three groups were showed significant results with respect to most of the objective and subjective parameters. Among three groups, Group C was effective showing the synergistic effect of Yoga and yava based diet. The treatment is cost effective and devoid of side effects, so it can be applied in the community easily.

KEYWORDS: Diabetes mellitus, Prameha, Madhumeha, Yava, Barley, Yogic practices.

INTRODUCTION

The present era is full of chaos, stress & strain opens the door to several diseases due to change in lifestyle and dietary habits, urbanization and industrialization. This has lead in the upsurge of silent killer known as *Diabetes mellitus*. Diabetes is a chronic metabolic disorder, burning and challenging problem for medical science with worldwide distribution. Among them Type II diabetes (NIDDM) is commonest type accounting for almost 90% of all diabetes. It is potential risk factor for microvascular and macrovascular complications. On the basis of its disease symptomatology Madhumeha of Ayurveda can be correlated to the features of Diabetes mellitus. Though Madhumeha is a disease known since

ancient times to the mankind, its upsurge is quiet alarming. The World Health Organization (WHO) estimates that nearly 200 million people all over the world suffer from Diabetes & this number is likely to be doubled by 2030.^[1] In India there are nearly 50 million diabetics, according to statistics of the International Diabetes Federation. In India, it is also 3rd leading cause of death (after heart disease and cancer). Data says every 10 seconds a person dies from Diabetes related disorders. An epidemiological study have reported that 75 % of diabetics are obese and they can control the disease by diet therapy and exercise.^[2] In management of Diabetes mellitus type 2, lifestyle management with dietary modification are essential. Yava (Barley) included in

daily life results in prevention and management of DM type II. Yava due to its agnivaradhana, lekshana and doshanulomana property, is selected in this study for evaluating its hypoglycemic actions.

Yava or Barley (*Hordeum vulgare*) is one of the most ancient cereal and best pathya in madhumeha as per Ayurveda. The use of Yava for food and medicinal purposes dates to antiquity. In *Charaka Samhita*, Yava is mentioned as a daily indicated diet. Yava has kashaya, madhura rasa, ruksha, laghu guna with shita virya and katu vipaka as per Ayurvedic pharmacodynamics. Recent recommendations for the dietary management of diabetes mellitus states that diet needs to be individualized, so that there is need to control glucose and lipid in diabetics. In a majority of individuals with diabetes, this is best done with a *diet that is low in fat and high in complex carbohydrate*, particularly whole grain cereals. Cereals such as barley are particularly high in the soluble fiber β -glucan, a 50% reduction in glycemic peak can be achieved with a concentration of 10% β -glucan in a cereal food. A significant lowering of serum cholesterol concentrations can also be anticipated with the daily consumption of ≥ 3 gm of β -glucan.

Yogic practices have been known for centuries to improve physical stamina and provide mental relaxation. Recent researches have recognized Diabetes as a psychosomatic disorder with causative factors being sedentary habits, physical, emotional and mental stress. Yoga has been shown to be a simple and economical therapeutic modality that may be considered as beneficial adjuvant for type 2 diabetes.^[3,4] Yogic exercise needs minimum energy consumption and maximum rehabilitative effects on vital organs^[5] including endocrine glands, by improving their microcirculation and functional efficiency as a result of good supplementation of Oxygen and nutrients to vital organs as well as removing carbon dioxide, other excess accumulated toxic metabolites from the cells. The researches have proved that they reduce stress, lipid level and body weight which is chief culprits in Diabetes mellitus. The contractions and relaxations of muscles during the practice of Asanas help in proper glucose uptake by the tissues. Thus helps in reducing blood sugar. The Yogic practices have a holistic effect leading to balance of body and mind, thus help to face the physical and mental stress effectively.

It seems that issues depicted above can be tackled with the holistic approach of Ayurvedic therapeutics by utilizing the package of Ayurvedic herbs, specific diet regimen, and Yoga measures in the cases of type-II DM.

AIMS & OBJECTIVES

- To evaluate the efficacy of Yava (barley) based diet in management of Diabetes mellitus (Madhumeha).
- To study the effect of Yogic practices in the management of DM.

MATERIAL AND METHODS

Present study was conducted at Swasthyarakshana OPD of Swasthavritta and Yoga and OPD of Department of Kayachikitsa in Ayurvedic wing of S.S Hospital, IMS, BHU, Varanasi, India. The approval was obtained from DRC of the department of Swasthavritta and Yoga and Institutional Ethical committee before the commencement of the study. About 60 patients of DM type II belonging to different age groups, gender and socio-economic status were selected based on the fulfillment of diagnostic criteria and randomly allocated into 3 groups (20 patients in each group) after getting their written informed consent.

Inclusion criteria

Patients fulfilling the following general and diagnostic criteria will be selected for the present study

- 1) Age group of patients was between 30 to 60 years.
- 2) The newly diagnosed cases as well as the patients under oral medication were selected for the study.
- 3) Patient willing to undergo treatment.

Diagnostic Criteria

(A) Clinical Diagnosis

Patients fulfilling the signs and symptoms of *Madhumeha* as per Ayurvedic classics.

(B) Laboratory Diagnosis

1. Patients having fasting blood sugar level ≥ 126 mg/dl up to 200mg/dl or
- 2 hour Post Prandial Blood Sugar ≥ 200 mg/dl upto 300 mg /dl.
2. Patient HbA_{1c} % is 6.5 % - 7.5%

Exclusion criteria

1. All patients of diabetes mellitus receiving insulin.
2. Patients having chronic complications of diabetes mellitus like- Micro vascular: Retinopathy, Neuropathy & nephropathy. Macro-vascular: Coronary Artery Disease, Peripheral vascular disease & Cerebro -vascular disease
3. The patient not willing to be included in the study.
4. Patients below 30 years and above 60 years
5. Patients having Fasting Blood Sugar >200 mg/dl and Post Prandial Blood Sugar >300 mg/dl.
6. Patients having HbA_{1c} % < 6.5 % and > 7.5 %.

Study design and treatment schedule

A total 60 patients with evidence of Diabetes and fulfilling the proposed criteria of selection were enrolled for clinical trial. These 60 cases of Type II Diabetes mellitus who were already under the Ayurvedic Treatment, will be selected after getting their consent for the study. The patients were randomly allocated into 3 groups (20 patients in each group).

The study was randomized, comparative & prospective study.

(a) **Group A:** (Control) Ongoing Ayurvedic Treatment (Nisha-amlaki & Shilajatu)

(b) **Group B:** Ongoing Ayurvedic Treatment + *Yava based diet*

(c) **Group C:** Ongoing Ayurvedic Treatment + *Yava based diet + Yogic practices*

All the patients were educated about general pathyapathy regimens.

GROUP A

The patients in group A were administered with **Nisha-amlaki Churna** (8 gm with lukewarm water BD) and **Shilajeet rasayana** (500 mg with cow's milk) after meal.

GROUP B

The patients in group B were treated with *Yava based diet* additional to ongoing ayurvedic treatment as given in group A: Chapatis/Rotis made of flour (1/4th barley + 3/4th wheat) or Daliya of Yava (Barley Porridge) or Yava sattu (Barley Roasted Flour), along with 1 gm of black pepper powder mixed with it. (*Total quantity of Yava to be consumed per day should be 100 grams*).

GROUP C

The patients belonging to Group C were advocated with Yogic practices additional to *Yava based diet* and ongoing ayurvedic treatment as prescribed in group B. Patients of this group were advised to practice the following yoga schedule.

➤ YOGA SCHEDULE.

(A) **Joint Movement: 5 rounds each side / day** Toes: Flexion and extension, Foot: Flexion and extension, Ankle: Rotation, Knee: Rotation, Hip: Rotation, Finger: Flexion and Extension, Wrist: Rotation, Elbow: Flexion and Extension, Shoulder: Rotation, Neck: Rotation.

(B) *Asanas*

1. **Standing:** Padahasthasana, Ardha-katichakrasana, Trikonasana for 5 Rounds
2. **Sitting:** Vajrasana, Mandukasana for 5 Rounds
3. **Prone position:** Bhujangasana, Shalabhasana for 5 Rounds
4. **Supine position:** Pavanamuktasana Naukasana for 5 Rounds.

(D) **Shavasana:** for 5 – 10 minutes

(E) **Shatkarma:** Kapalabhati for 10 mins

(F) **Pranayama:** Anuloma–Viloma for 5 mins, Bhramari for 3 mins.

(G) **Dhyana:** Omkara Dhyana for 10 mins.

60 patients were registered and randomly allocated into three groups out of which 2 patients in Group A, 1 patient in Group B and 2 patients in Group C dropped out at different stages of the study without any specific reason. Total 55 patients (18 in Group A, 19 in Group B and 18 in Group C) fully co-operated in the course of completion of the research study. The data collected were tabulated and analysed using statistical software SPSS version 16.0. The intragroup comparison was done to see the effect of treatment using Friedman's test for subjective parameters and paired t-test for objective

parameters. The intergroup comparison between different groups for subjective parameters were done by Pearson's Chi-square test and objective parameters were done by One Way ANOVA (Analysis of Variance) and value of F test was determined. Wherever F test resulted statistically significant, post-hoc test was applied for multiple comparisons, identifying significant pairs of the groups.

OBSERVATIONS AND RESULTS

Demographic Profile: In the present study maximum patients (46.7%) were belonging to 41-50 years age group. Majority of patients were males (65.0%), and belonged to Hindu religion (88.3%). Further, maximum patients were graduates (23.4%) belonging to middle class (71.7%). Regarding occupation maximum patients were housewives (33.3%) followed by patients in service (31.7%). Maximum patients were residing in urban area (61.7%).

Constitutional profile: Regarding body constitution maximum patients had *Vatapradhana* (50.0%), followed by 38.3% having *Kaphapradhana*, and 11.7% of patients had *Pittapradhana Prakriti*. Further in *Manasa Prakriti* maximum patients had *Tamasika* (73.3%) and *Rajasika Manasa Prakriti* (26.7%). Regarding *Sattvabala* maximum patients had *Madhyama Sattvabala* (78.3%). In the aspect of body mass index (BMI) maximum patients (58.3%) had BMI in the range of 25.0 - 29.9 (BMI Asian Obese category)^[6] followed by (23.3%) of patients having BMI 23.0 - 24.9 (BMI Asian Overweight category) and 13.3% patients were BMI (≥ 30) [BMI Asian Morbidly-obese category], while only 5.0% of the patients had BMI between 18.5 - 22.9 (BMI Asian Normal category). Out of 60 patients, 23 patients (38.3%) had positive family history. Addiction for oral tobacco consumption was found in 26.7% of patients. This was followed by 11.6%, 6.7% patients addicted to smoking, and alcohol respectively, while 55.0% of patients had no addiction. Further maximum patients (61.7%) had mixed dietetic nature, followed by 38.3% of patients were vegetarian in nature. Most patients (56.7%) had irregular dietary habits either time-wise or quantity-wise, while 43.3% of patients were taking their meals timely, regularly and in proper quantity. Maximum patients (60.0%) had *Madhyama Koshta*, followed by 36.7% with *Krura koshta* and 3.3% with *Mridu koshta*. In the present study maximum patients (55.0%) the chief culprit in pathogenesis was *Kapha Dosha*, followed by *Vata dosha* in 36.7%, and *Pitta dosha* in 8.3% patients. While maximum patients (60.0%) the main *dushya* involved in pathogenesis was *Rasa*, followed by *Meda* in 40.0% patients.

Effect of Treatment on Subjective Criteria

➤ On intragroup comparison there was significant remission of severity with respect to subjective parameters like *Atipipasa* (Polydipsia), *Atimutrata* (Polyurea), *Alasya* (Laziness), *Atikshudha* (Polyphagia), *Mukha-shosha* (Dryness in mouth), *Atisveda* (Excessive

Sweating), *Atinidra* (Excessive Sleep), *Hastha-pada Daha* (Burning sensation), *Sheeta priyata* (Liking of Cold things), *Shithilangata* (Flabbiness) and *Hastha-pada shunyata* (Numbness), in all the three trial groups after treatment as compared to pretreatment grades. Further the results were statistically highly significant ($p < 0.001$).

➤ Inter group comparison, with respect to *Atipipasa* (Polydipsia), *Atimutrata* (Polyuria), *Alasya* (Laziness), *Atikshudha* (Polyphagia), *Mukha-shosha* (Dryness in mouth), *Atisveda* (Excessive Sweating), *Atinidra* (Excessive Sleep), *Hastha-pada Daha* (Burning sensation), *Sheeta priyata* (Liking of Cold things), *Shithilangata* (Flabbiness) and *Hastha-pada shunyata* (Numbness) was not statistically significant at 1st and 2nd FU whereas it was statistically significant at 3rd FU. There was no significant difference statistically with respect to *Alasya* (Laziness). On the whole, intergroup comparison shows efficacy in the order Group C > Group B > Group A.

Effect of Treatment on Objective Criteria

➤ **Fasting Blood Sugar (FBS):** On intragroup comparison (between BT and AT) the effect of therapy (Table 2) was significant in all the 3 groups. On Intergroup comparison (One-way ANOVA) of mean FBS was found statistically highly significant at 2nd & 3rd Follow Ups ($p < 0.001$), while statistically not significant at 1st FU. On the basis of mean reduction & maximum response, the efficacy of treatment given to different trial groups was in the order Group C > Group B > Group A.

➤ **Post Prandial Blood Sugar (PPBS):** On intragroup comparison the results were significant in all the 3 groups. While the Intergroup comparison (Table 3) was found statistically highly significant at 3rd FU ($p < 0.001$), while significant at 2nd follow-up ($p < 0.05$). On

the basis of mean reduction & maximum response, the efficacy of treatment given to different trial groups was in the order Group C > Group B > Group A.

➤ **Glycated Haemoglobin (HbA_{1c}):** The Intergroup comparison (Table 4) shows statistically highly significant results after treatment. On the basis of mean reduction, the efficacy of treatment given to different trial groups was in the order Group C > Group B > Group A.

➤ **Serum Cholesterol:** The Intergroup comparison (Table 5) shows statistically highly significant results. On the basis of mean reduction & maximum response, the efficacy of treatment given to different trial groups was in the order Group C > Group B > Group A.

➤ **Serum Triglyceride:** The Intergroup comparison shows statistically highly significant ($p < 0.001$), after treatment. On the basis of mean reduction & maximum response, the efficacy of treatment given to different trial groups was in the order Group C > Group B > Group A.

➤ **Serum Creatinine:** The Intergroup comparison (Table 6) shows statistically highly significant ($p < 0.001$) result. On the basis of mean reduction & maximum response, the efficacy of treatment given to different trial groups was in the order Group C > Group B > Group A.

➤ **Blood Urea:** On Intergroup comparison (Table 7) the results were statistically not significant. However, on the basis of mean reduction in Blood Urea, the efficacy of treatment may be given in the order Group C > Group B > Group A.

➤ **Body Mass Index (BMI):** On Intergroup comparison (Table 8) the results were statistically not significant. However, on the basis of mean reduction in BMI, the efficacy of treatment may be given in the order Group C > Group B > Group A.

Table 1: General Pathyapathya advocated in all three groups.

Group	Name of items
Grains	<i>Yava</i> (barley)- <i>Hordeum vulgare</i> , <i>Godhuma</i> (Wheat)- <i>Triticum sativum</i> , <i>Shashtika Shali</i> (rice)- <i>Oryza sativa</i> , <i>Bajara</i>
Pulses	<i>Chanaka</i> (bengal gram)- <i>Cicer arietinum</i> , <i>Adhaki</i> (toor dal)- <i>Cajanus cajan</i> , <i>Mudga</i> (green gram)- <i>Phaseolus aureus</i> ,
Vegetables (bitter & astringent)	<i>Methika</i> (fenugreek)- <i>Trigonella foenum graecum</i> , <i>Patola</i> (pointed gourd)- <i>Trisanthus dioica</i> , <i>Karvellaka</i> (bitter gourd)- <i>Momordica charantia</i> , <i>Tanduleyaka</i> (<i>Choulayee</i>)- <i>Amaranthus spinosus</i> , <i>Vastukam</i> (<i>Bathuva</i>), <i>Shobhanjana</i> (drum stick)- <i>Moringa oleifera</i> , <i>Karkotaka</i> – <i>Momordica dioica</i> , <i>Rasona</i> (garlic)- <i>Alium sativum</i> , <i>Bimbi</i> (kundru)
Fruits	<i>Jambu</i> (Jamun)- <i>Eugenia jambolana</i> , <i>Amalaki</i> (goose berry)- <i>Emblica officinalis</i> , <i>Dadima</i> (pomegranate) – <i>Punica granatum</i>
Seeds	<i>Methika</i> , <i>Atasi</i>
Oils	<i>Atasi</i> (<i>Linum usitatissimum</i>), <i>Sarshapa</i> (Mustard)
Others food articles & spices	<i>Dhani</i> (pop corn of jowar), <i>Laja</i> Murmura (puffed rice), <i>Maricha</i> – (<i>Piper nigrum</i>), <i>Saindhava</i> – (rock salt), <i>Hingu</i> - (<i>asafoetida</i>), <i>Haridra</i> - (<i>Turmeric</i>), <i>Ardraka</i> - (<i>Ginger</i>)

Table 2: Effect of Trial Treatment on Fasting Blood Sugar (FBS) (n=55).

Groups	Fasting Blood Sugar (Mean \pm SD)				Within the group comparison, Paired 't' test, (BT - FU3)
	BT	FU1	FU2	FU3	
Group A (n=18)	164.44 \pm 25.03	150.17 \pm 22.39	142.93 \pm 20.72	146.04 \pm 28.41	18.40 \pm 16.26 t = 4.802, p < 0.001 HS
Group B (n=19)	162.58 \pm 24.95	137.77 \pm 19.15	127.51 \pm 9.25	117.42 \pm 7.37	45.16 \pm 23.27 t = 8.459, p = 0.001 HS
Group C (n=18)	163.99 \pm 21.78	139.67 \pm 12.17	125.28 \pm 11.75	103.61 \pm 5.84	60.38 \pm 23.69 t = 10.811, p < 0.001 HS
Between the group comparison, (One-Way ANOVA)	F=.030 p= 0.970 NS	F= 2.4 P=0.101 NS	F=7.774 p=0.001 HS	F=28.732 P<0.001 HS	-
Post-Hoc test, Group A vs Group B Group A vs Group C Group B vs Group C	-	-	P=0.007 P=0.002 P=1.000	P<0.001 P<0.001 P=0.053	

Table 3: Effect of Trial Treatment on Postprandial Blood Sugar (PPBS)(n=55).

Groups	PPBS (Mean \pm SD)				Within the group comparison, Paired 't' test, (BT - FU3)
	BT	FU1	FU2	FU3	
Group A (n=18)	254.32 \pm 35.20	219.40 \pm 37.94	189.68 \pm 29.33	200.68 \pm 30.18	53.64 \pm 36.07 t = 6.308, p < 0.001, HS
Group B (n=19)	263.17 \pm 28.19	217.56 \pm 26.77	180.53 \pm 18.79	165.11 \pm 16.62	98.06 \pm 26.287 t = 16.261, p < 0.001, HS
Group C (n=18)	261.69 \pm 25.90	221.33 \pm 20.03	169.72 \pm 19.04	146.83 \pm 17.43	114.86 \pm 28.785 t = 16.928, P < 0.001, HS
Between the group comparison, One- Way ANOVA	F=0.456 P=0.636 NS	F=.077 P=0.926 NS	F=3.443 P=0.039 S	F=27.420 P < 0.001 HS	-
Post-Hoc test Group A vs Group B Group A vs Group C Group B vs Group C	-	-	P=0.686 P=0.034 P=0.470	P < 0.001 P < 0.001 P=0.047	-

Table 4: Effect of Trial Treatment on HbA1c % (n=55).

Groups	HbA1c % (Mean \pm SD)		Within the group comparison, Paired 't' test, (BT - FU3)
	BT	FU3	
Group A (n=18)	8.09 \pm 0.93	7.03 \pm 0.48	1.06 \pm 0.61 t = 7.405, p < 0.001, HS
Group B (n=19)	8.35 \pm 0.74	6.50 \pm 0.30	1.85 \pm 0.76, t = 10.619, p < 0.001, HS
Group C (n=18)	8.91 \pm 0.80	6.36 \pm 0.42	2.54 \pm 0.69 t = 15.58, P < 0.001, HS
Between the group comparison, One- Way ANOVA	F=4.514 p=0.016, HS	F=13.722 P < 0.001, HS	-
Post Hoc test Group A vs Group B Group A vs Group C Group B vs Group C	p = 1.000 p = 0.015 p = 0.144	p = 0.001 p < 0.001 p = 0.914	-

Table 5: Effect of Trial Treatment on Serum Cholesterol (n=55).

Groups	Serum cholesterol (Mean \pm SD)		Within the group comparison, Paired 't' test (BT - AT)
	BT	AT	
Group A (n=18)	233.08 \pm 45.608	208.49 \pm 35.124	24.59 \pm 26.05 t = 4.006, p = 0.001, HS
Group B (n=19)	240.11 \pm 53.964	173.37 \pm 22.628	66.74 \pm 43.53 t = 6.683, p < 0.001, HS
Group C (n=18)	269.06 \pm 48.846	162.44 \pm 21.667	106.61 \pm 48.24 t = 9.376, P < 0.001, HS
Between the group comparison, One- Way ANOVA	F=2.662 P = 0.079, NS	F=14.237 P < 0.000, HS	-
Post-hoc test Group A vs Group B Group A vs Group C Group B vs Group C		P=0.001 P < 0.001 P=0.677	

Table 6: Effect of Trial Treatment on Serum Triglyceride (n=55).

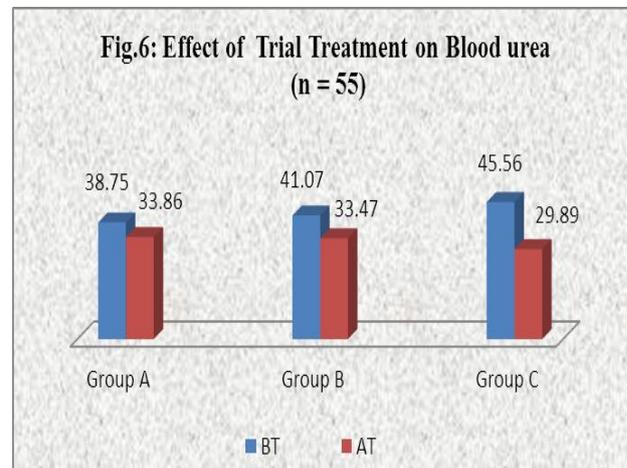
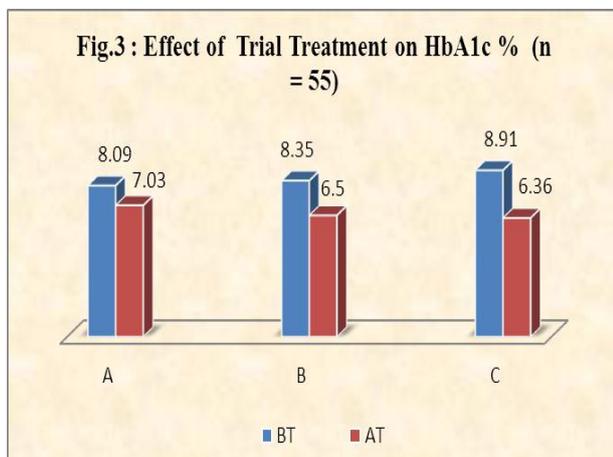
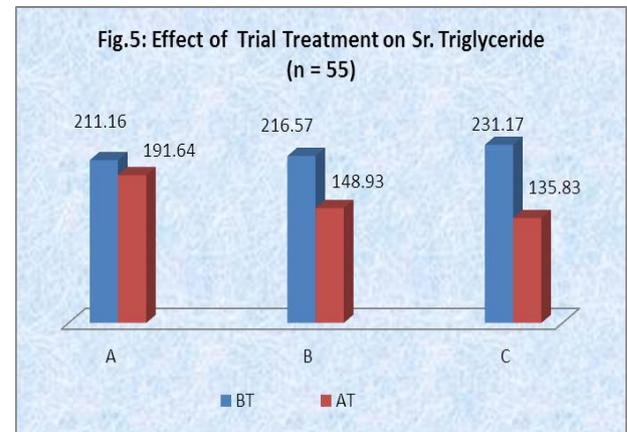
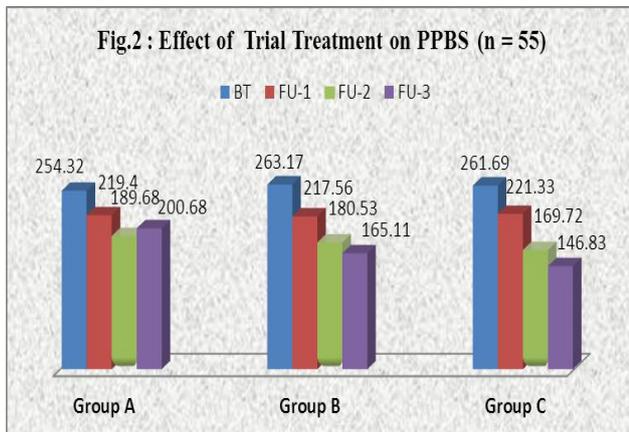
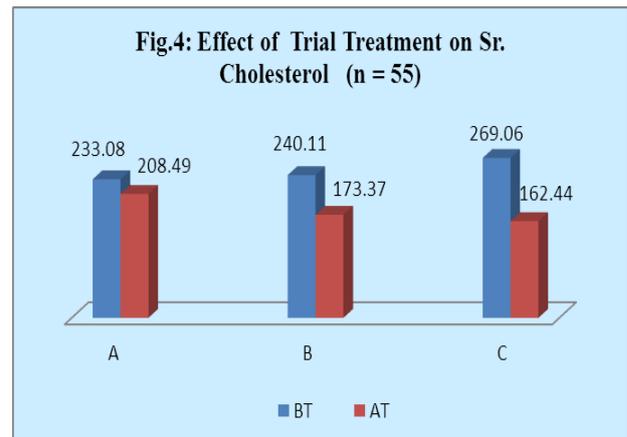
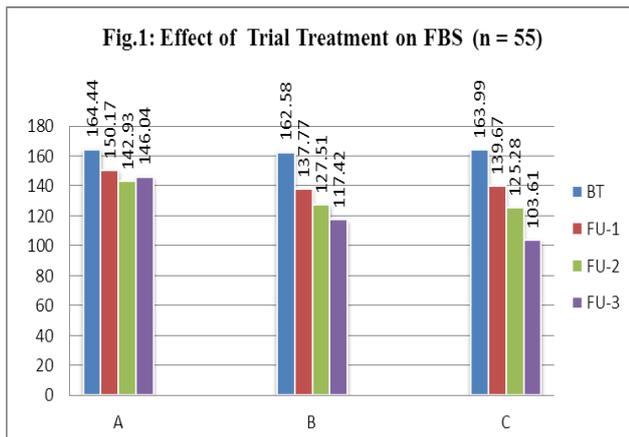
Groups	Serum Triglyceride (Mean \pm SD)		Within the group comparison, Paired 't' test, (BT - AT)
	BT	AT	
Group A (n=18)	211.16 \pm 32.993	191.64 \pm 31.201	19.52 \pm 15.89 t = 5.212, p < 0.001, NS
Group B (n=19)	216.57 \pm 62.304	148.93 \pm 21.337	67.64 \pm 48.62 t = 6.063, p < 0.001, HS
Group C (n=18)	231.17 \pm 53.282	135.83 \pm 14.533	95.33 \pm 55.92 t = 7.232, p < 0.001, HS
Between the group comparison, One- Way ANOVA	F=0.736 p=0.484, NS	F=28.220 P < 0.001, HS	-
POST HOC Group A vs Group B Group A vs Group C Group B vs Group C		p < 0.001 p < 0.001 p = 0.282	

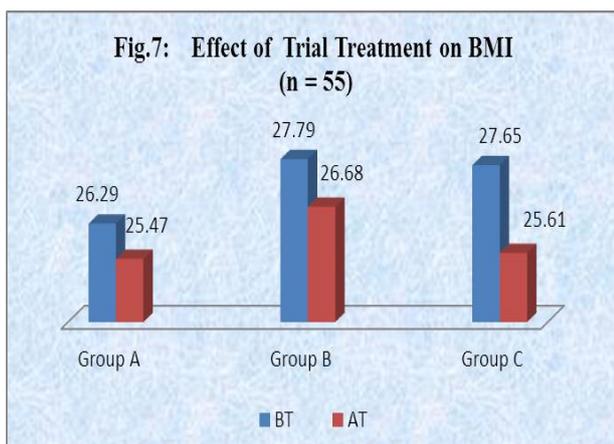
Table 7: Effect of Trial Treatment on Blood Urea (n=55).

Groups	Blood Urea (Mean \pm SD)		Within the group comparison, Paired 't' test, (BT - AT)
	BT	AT	
Group A (n=18)	38.75 \pm 7.543	33.86 \pm 7.000	4.89 \pm 3.87 t = 5.363, p < 0.001, HS
Group B (n=19)	41.07 \pm 6.830	33.47 \pm 4.039	7.60 \pm 6.62 t = 5.004, p < 0.001, HS
Group C (n=18)	45.56 \pm 8.212	29.89 \pm 5.687	15.67 \pm 5.21 t = 12.750, p < 0.001, HS
Between the group comparison, One- Way ANOVA	F= 3.797 p= 0.029, S	F= 2.696 p= 0.077, NS	-

Table 8: Effect of Trial Treatment on Body Mass Index(n=55).

Groups	BMI (Mean \pm SD)		Within the group comparison, Paired 't' test, (BT - AT)
	BT	AT	
Group A (n=18)	26.29 \pm 2.365	25.47 \pm 1.998	0.828 \pm 0.695 t =5.053, p < 0.001, HS
Group B (n=19)	27.79 \pm 2.228	26.68 \pm 2.134	1.105 \pm 0.642 t = 7.504, p < 0.001, HS
Group C (n=18)	27.65 \pm 2.409	25.61 \pm 1.605	2.046 \pm 1.101 t = 7.884, P < 0.001, HS
Between the group comparison, One-way ANOVA	F= 2.283 P= 0.112, NS	F= 2.211 P= 0.120, NS	-





DISCUSSION

Demographic data: In the present study maximum patients (46.7 %) were belonging to the upper middle age group i.e. 41-50 years, followed by (40.0 %) were from the older age group i.e 51- 60 years, this reveals that maximum prevalence of the disease at Madhyama Avastha. These findings were concordant to the recent statistical data, which shows that the onset of Type II Diabetes mellitus after the 40's is most common. Decreased physical activity could be the cause behind this finding. This observation supports the fact that Type 2 DM has maturity onset as total 86.7% of people [46.7%+ 40%] were between age group 41-60 years. Regarding the educational status maximum patients had completed graduation or above (36.7%) followed by (23.3%) patients having intermediate education. This may be due to the sedentary lifestyle of their workplace and related work. Regarding the socioeconomic status maximum patients belonged to middle class (71.7%) followed by lower class (23.3%). This may be due to high intake of fast foods or oily stuff added with reduced physical activity by middle income people as compared to low income groups. Regarding occupation status maximum patients were either in service or in business (31.7+23.3= 54.0 %) followed by housewives (33.3%). Increased incidence in Servicemen & businessmen may be due to their faulty lifestyle, stressful mental work and reduced physical activity and lack of exercise as a result of busy work schedules. They also consumed excess tea/coffee, fast foods, or canteen foods rich in calories and fat leading to obesity. Housewives are mostly adapted to a sedentary lifestyle which in turn results in diabetes and deal with stressful conditions. Regarding the habitat status, study reflected that maximum patients belonged to urban area (61.7%) and this data is concordant with the W.H.O. annual report (2000) that the prevalence of Diabetes mellitus is greater in urban than in rural areas. This shows the effect of fast foods, sedentary life, sudden change in life style in urban areas, however increasing incidence in rural may be due to lack of health awareness. The effect of urbanization has increased the propensity of this lifestyle disease.

Regarding Deha Prakriti maximum patients belonged to *Vatapradhana* (50.0%) and *Kaphapradhana prakriti* (38.3%). This may be due to the fact that vatapradhna prakriti persons generally due to rajas dosha dominancy lives frenetic, fluxes of mood and stressful life, irregular lifestyle pattern leads to disturbed metabolism, liable to *Ama dosha* formation that ultimately makes them prone to diabetes. It was noted that *Tamasika manas prakriti* was found in maximum 73.3% of patients, followed by patients having *Rajasika* 26.7% of patients. Because of dominance of *Rajas* and *Tamas* at *Manas* level emotional make up like depressiveness, anxiety and anger were predominantly present. *Tamasic* persons practices excessive sleep, lazy, sedentary lifestyle and excessive indulgence in food which in turn disturbed the doshik balance in the body and leads to madhumeha. *Rajasic* persons are always of wandering moods and concentration, they were inclined towards anxiety, anger and fears, alcoholism, smoking, etc. which further predispose towards diabetes. Maximum patients had BMI in the range of 25.0 – 29.9 kg/m² (BMI Asian Obese Grade) followed by 23.3% of patients having BMI 23.0 - 24.9 kg/m² (BMI Asian Overweight category), 13.3% patients were BMI (≥ 30 kg/m²) [BMI Asian Morbidly-obese category]. The increased BMI is associated with dyslipidemia or hyperlipidemia which will hampers the normal metabolism of the patient and predisposes subjects to the metabolic disorders like DM.^[7] Regarding the family history Diabetes was found positive in 38.3% patients, which is comparable to Prameha as Kulaja vikara of Ayurvedic lexicons. Besides it also indicates that with strong genetic predisposition of DM in population belonging to the study area. In the present study addictions of tobacco (chewing), smoking and alcohol consumption were found 26.6%, 11.6% & 6.7% respectively. It indicates that persons having such type of addictions are more liable to develop Diabetes. 56.7% patients were found having irregular Dietary habits (*Adhyashana* or *vishamashana*) i.e meals taken without proper digestion of previous meal is called *Adhyashana* (*A.S.Su.10/33*), the meal taken before or after the proper timing of the food is *Vishamashana* (*A.S.Su.10/33*). This untimely taken meals in due course of time known to cause *Agni dushti* which might leads to *Ama* formation that later causes *vata prakopa* through *avarana* formation, these consequences leads to *Ojo-dushti* & is the key to the pathogenesis of madhumeha. Maximum no. of patients were of madhyama koshta(60.0%) followed by Krura(36.7%) and Mridu koshta (3.3%). This indicates dominance of kapha dosha in their constitution, thus makes them prone for metabolic disorders. Regarding Dosha Involvement *Sthilangata* & *Hastha-pada shunyata* like doshaja lakshana was prominent in *Vata* dominant (36.5%) patient. In *Pitta* dominant (8.3%) patients lakshana like *Atipipasa*, *Atisweda*, *Hastha-pada daha* were present more abundantly than others. In *Kapha* dominant (55.0%) patients features like *Atimutrata*, *Alashya* and *Atinindra* are dominant. Regarding *Dushya* involvement, maximum patients (60.0%), the main *dushya* was *Rasa*,

followed by in 40.0% patients the dushya was Meda. This indicates the discrepancies in metabolism of maximum patients was due to the improper conversion of Ahara rasa into the proper rasa dhatu, so it disturbed the further dhatus interconversion.

❖ Effect of treatment on various objective criteria

➤ The mean FBS in Group B & C was lower as compared to Group A at 2nd & 3rd Follow ups (FU). This indicates that integration of barley diet and yogic practices with Ayurvedic drugs gradually reduces FBS load better in comparison to drug alone only.^[8]

➤ The mean PPBS in Group B & C was lower as compared to Group A at 2nd & 3rd FU. This reflects that (Drug+Barley+Yoga) treated group & (Drug + Barley) treated group responded much better than drug alone. Further, probably Yoga Therapy stimulates liver and pancreatic functions and improves blood circulation in whole body and cellular channels and enhances mobilization of blood sugar from central to peripheral compartment & thus reduced PPBS. Barley diet probably shows results because of slow glucose absorption due to gut viscosity. This might be responsible for the acute effects of β -glucan whereas the SCFA generated through colonic fermentation might be mediating the postprandial glucose effects at subsequent meals.

➤ On the basis of mean reduction in HbA_{1c}%, the efficacy of treatment given to different trial groups was in favour of group C > B > A. This is probably be due to delayed gastric emptying and slowed intestinal absorption due to the complex polysaccharide and high viscous nature. It prevents sudden fluctuation of blood sugar level. Regular practice of yoga and barley diet maintains the fluctuation of sugar and reflects satisfactory decrease in HbA_{1c}%, which is biomarker of long term glycemic control and for diabetic complications.

➤ The mean Serum Cholesterol in Group B & C was lower as compared to Group A after treatment. This is due to the adjunct hypolipidemic action of both barley diet and yoga. Barley fiber increases the excretion of bile acids into the intestines. Since these acids are comprised of oxidized cholesterol, this lowers total serum cholesterol.^[9] Studies have confirmed that barley lowers cholesterol^[10], low-density lipoprotein (LDL),^[11,12]

➤ The previous study of Pandey A.K and Singh R.H (2002 & 2012),^[13,14] Nisha-amalaki & Shilajatu are effectively control short-term (FBS, PPBS) and long-term glycemic index (HbA_{1c}) along with improved the status of impaired Ojas & Agni. The present study is also conforming the same along with additive effect of Yava based diet & yoga therapy. The additive effect of Yava diet and Yoga therapy is due to low Glycemic index of Yava based diet and Yoga therapy that imparts mental relaxation along with enhanced peripheral utilization of glucose. Thus by combining Yava based diet & Yogic practices, we can suppress or check the pathophysiology of Diabetes by providing the low calorie diet and improving the physical & mental faculties by utilizing Yoga therapy.

➤ On the basis of mean reduction in Blood Urea and Serum creatinine values, the efficacy of treatment given to different trial groups was group C > B > A. This probably due to the cleansing effect, improved metabolism and proper blood circulation in the body through yoga practices, also Deepan, Paachan, Lekhan properties of barley. But the improvement is fluctuated within the normal physiological range, which signifies that the selected trial measures does not impart any unwanted effect to the body systems especially kidney.

Effect of treatment on various subjective criteria

The difference in the results obtained is attributed to the favourable effects of the Barley along with the dietary and lifestyle changes in Group B and additional Yoga practices in group C over that of solitary Ayurvedic treatment alone in group A. The above findings are consistent with the Shoshana, Lekhana, Ama Pachana, Deepana, Agnivardhana and Doshanulomana properties of the yava, which results in stabilization of the agni in kosta and clearance of the channels obstructed by meda dhatu and thus reduction in Atitrishna, Sheeta Priyata, Hastha-pada Shunyata, Hastha-pada Daha, Atisveda, Alasya, Atinidra, Shithilangata, Atimutrata, Atikshudha, Mukha-Shosha, reduction in Alasya, Atinidra, Shithilangata can also be attributed by the positive effects of yogic practices.

Mode of action of Yava (Barley) in Diabetes:

Ayurvedic Concept: In Ayurveda the pharmacological action of can be attributed to Kashaya, Madhura rasa, Guru, Ruksha, Pichhala and Sara guna; Sheeta virya and Katu vipaka. It is Kapha pittahara and vata vardhaka in nature. Due *kashaya rasa, ruksha guna*, it dries the excess *Kleda* from body through *shoshana* effect. The *vayu* is responsible for clarity among channels, *shoshana* of *dosha* and stimulation of *agni*, *katu vipaka dravya* are generally said to be *Lekhnaya* due to predominance of *vayu*, *agni* and *akash mahabhuta*. After the *dhatvagni* and *bhutagni paka*, they reduce *kapha* and homologues *dhatu*. Owing to these properties *yava* helps to stabilize the *agni* in *kosta*, clear the channels obstructed by *meda* due to *Lekhana guna* and also brings about *medodhatu vilayana*. This helps in counteracting the culprit *Medodushti* leading to control of obesity as well as blood sugar levels in diabetes. The *Guru*, *Ruksha gunas* help to rectify deranged *agni* in *madhumeha*. Due to *pureesha-vardhaka property* it acts as *doshanulomana*. *Yava* also reduces the *dhatushaithilaya in prameha* and improves glucose and lipid control in the patients. Acharya charaka has also mentioned *guru (aahar)* and *apatarpana chikitsa* for management of *sthula pramehi*.

❖ **Modern Concept:** Modern literature reveals that *beta glucan* (active chemical in barley) is responsible for anti-hyperglycemic activity and also helpful in reducing lipids. Even though precise physiological mechanism of action by which barley β -glucan reduces glycemic response is not known, in general, barley's β -glucans have very high molecular weight complex

polysaccharides with high viscosity. Consequently, consumption of this viscous fibre having *gel forming properties* of β -glucan tends to increase the viscosity of the entire meal bolus in the stomach, which prevents or delays the action of digestive enzymes on food and food components.^[15,16,17] This might also result in delayed gastric emptying. In addition, increased viscosity has been shown to inhibit intestinal glucose absorption. *In vivo* studies and several *in vitro* digestion experiments have validated this notion that β -glucan can slow down the rate of starch digestion.^[18,19,20] Moreover, being a soluble dietary fibre, β -glucan can undergo fermentation in the large intestine by the gut microbiota to produce short-chain fatty acids (SCFA) including acetate, propionate and butyrate. Reduced glucose absorption due to gut viscosity might be responsible for the acute effects of β -glucan, whereas the SCFA generated through colonic fermentation, might be mediating the postprandial glucose effects at subsequent meals.^[21,22,23] Also increased viscosity in intestine disturbs micelle formation, which may inhibit cholesterol absorption, slow cholesterol transfer across the unstirred layer and increase bile acid excretion by inhibiting bile acid re-absorption.^[24] (Reducing serum cholesterol concentrations has been shown to reduce the risk of coronary artery disease (CAD). It is hypothesized that the beneficial effects on glycemic control from consumption of barley β -glucan can be attributed to its rheological properties, or viscosity, in the gut.^[25] Pichhala property (told by Sushrutacharya)^[26] is proving the gel forming activity of beta glucan and providing some sliminess in tract. Yava has guru property means it will take much time for digestion and remain for long time in intestinal tract because of which person feel fullness for a long duration and it can be concluded that increased bile acid is excreted out due to its sara property. Most of the cereals being low in fat and high in carbohydrate, however tend to have high Glycemic Index (GI). But barley is exception for this, hence barley with low glycemic index can be used to improve glycemic control and to prevent future diabetic complications.^[27]

➤ **The Role of Some Micronutrients of Yava In Diabetes:** **Niacin:**-Niacin (nicotinamide) may help to preserve residual B-cell function in individuals with type 1 or type 2 Diabetes. This B-vitamin is believed to be one of the components of the glucose tolerance factor (GTF). **Vitamin B6:**-Research shows that a deficiency of vitamin B6 may result in abnormal glucose tolerance, degeneration of the pancreatic beta cells, reduced insulin response to glucose and reduced serum and pancreatic insulin levels. In addition, vitamin B6 deficiency has been associated with polyneuropathies. **Calcium:**-Studies have shown that individuals with a low intake of calcium have an increased risk of non-insulin dependent diabetes mellitus. Numerous studies have also revealed that diabetes may be associated with abnormal regulation of intracellular calcium. **Zinc:**-This mineral has been associated with over 200 enzymatic functions in the body. Increased fasting blood glucose levels have been

associated with low zinc. Zinc has been shown to be important in the synthesis, storage and secretion of insulin. Increased urinary zinc excretion has also been associated with diabetic individuals.

➤ **Mode of action of Yoga Therapy:** Glucagons secretion is enhanced by stress.^[28] Yoga effectively reduces stress,^[29] Yoga reduces adrenaline, noradrenalin and cortisol in blood, which are termed as 'Stress hormones', thus reducing glucagons and possibly improving insulin action. Weight loss induced by yoga is a well-accepted mechanism. The effect of yogasanas on lipoprotein profiles was proven to significant decrease in the free fatty acids, LDL and VLDL cholesterol, and increase in HDL cholesterol.^[30] Muscular relaxation, development and improved blood supply to muscles might enhance insulin receptor expression on muscles causing increased glucose uptake by muscles and thus reducing blood sugar. Blood pressure plays a great role in development of diabetic and related complications, which is proven to be benefited by yoga. The same holds true for increased cholesterol levels. This is a likely mechanism of improvement in insulin action. Many yogic postures do produce stretch on the liver and pancreas, which is likely to stimulate the pancreatic function and improves metabolism through liver stimulation and thus effective peripheral glucose utilization.

CONCLUSION

- The features of diabetes mellitus resembles with the features of *Madhumeha*, one of the diseases produced due to the vitiation of kapha and vata dosha.
- The Intra-group comparison show that all the three groups are effective in control of diabetes mellitus.
- On inter-group comparison, the Yava based food and Yogic practices along with Ayurvedic medication have additive effect, hence Group C advocating said combination is more effective with respect to objective and subjective parameters in Diabetes mellitus patients.
- The treatment is non-pharmacological, cost effective, safe and devoid of side effects, so it can be applied in the community easily.

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