

THE EFFECT OF WHEAT GRASS JUICE IN TYPE-2 DIABETES MELLITUS

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Article Received on
22 Jan. 2020,

Revised on 12 Feb. 2020,
Accepted on 03 March 2020,

DOI: 10.20959/wjpr20204-17052

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ABSTRACT

Diabetes mellitus is a chronic metabolic disorder that occurs when the pancreas does not produce sufficient insulin or when the body cannot effectively use the insulin it produces. Globally it is estimated that 382 million people suffer from diabetes for a prevalence of 8.3%. Indians are more diabetic as compared to other countries. It affects more than 62 million Indians. The increase in incidence in developing countries follows the trend of urbanization and lifestyle changes. Deviation from traditional dietary habits also accounts for increased prevalence. Wheatgrass can be traced in history over 5000 years to ancient Egypt and perhaps even early Mesopotamian civilization. Dr. Ann Wigmore

was also a strong advocate for the consumption of wheatgrass as a part of Raw Food Diet. She was the founder of Hippocrates Health Institute believed that it would cleanse the body of toxins while providing a proper balance of nutrients to treat illness. Wheatgrass is the nature's finest medicine, its properties ranging from promotion of general wellbeing to cancer prevention. Wheatgrass contains chlorophyll, calcium, iron, magnesium, vitamins A, C, K, E and B-complex, selenium and certain amino acids. Hyperglycemia in diabetes generates reactive oxygen species and disturbs the endogenous antioxidant defense system that causes oxidative stress. Wheatgrass is a miraculous drug having antioxidants. The patients between age group 40 – 70 years were selected, who satisfied the inclusion and exclusion criteria with written inform consent. The patients were administered 50 ml Wheatgrass juice diluted with 50 ml water half an hour before morning food and half an hour before dinner daily. Blood sugar levels (fasting blood sugar and post prandial) and sign and symptoms of type 2 diabetes mellitus were reduced and was found statistically significant with appreciable percentage of relief.

KEYWORDS: Wheatgrass, Type-2 Diabetes Mellitus.

INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia along with specific long- term complications. It has a significant impact on the health, quality of life and life expectancy of patients as well as on the health care system. Allopathic drugs used to lower blood sugar may increase risk of death from all causes by 19 percent, and risk of cardiovascular mortality by 43 percent. Most of the modern treatments for type 2 diabetes mellitus utilize drugs that raise either insulin or lower blood sugar. Sedentary lifestyle, obesity and fast food meals have the characteristics that linked to insulin resistance. Insulin resistance in muscle and fat cells reduces glucose uptake whereas in liver cells insulin resistance leads to reduced glycogen synthesis and storage and also a failure to suppress glucose production and release into the blood. Obesity has been explained as the result of an imbalance between the intake of energy substrates and energy utilization.^[1] This imbalance promotes the shunting of substrates into anabolic pathways for synthesis and storage of fat.^[2] Obesity is referred to as condition when fat accumulation is excessive to an extent that it increases risk of ill health^[3] especially if it is stored in the abdominal region.^[4] Obesity is a frequent concomitant of type 2 diabetes, and in many longitudinal studies it is shown to be a powerful predictor of its development.^[5,6] Obesity has increased rapidly in many populations in recent years.^[7,8,9] because of an interaction between genetic and environmental factors. These include metabolic characteristic^[10]; physical inactivity^[11,12] habitual energy intake in relation to expenditure and macronutrient, micronutrient composition of the diet.^[13]

Stress can be associated with cortisol and low sex steroid concentrations. These antagonize insulin action and cause visceral adiposity, which may contribute to insulin resistance and the onset of type 2 diabetes mellitus.^[14] And hence the glycaemia aggravate. It has been suggested that the link between stress and diabetes may be through other factors such as chronic stimulation of the autonomic nervous system and its resulting hyperglycemia.^[15,16] Inflammatory consequences of psychological stress have been proposed as the link to insulin resistance and diabetes. Psychological stress via stimulation of the major stress hormones, norepinephrine and cortisol, the renin-angiotensin system, the pro-inflammatory cytokines and free fatty acid fluxes produces an inflammatory response by activation of nuclear factor kappa B in macrophages, visceral fat and endothelial cells. This process leads to insulin resistance and, if maintained, to increased risk for diabetes.

Naturopathy is the field of medicine that promotes physical, psychological and social health and well-being through a myriad of natural treatment approaches, which includes lifestyle management, herbal medicine, diet and nutrition management. It employs approach that views the body as an integrated whole, less invasive, less expensive and excels at health promotion, wellness, disease prevention and management. It believes in single cause of all diseases i.e. accumulation of morbid matters in body and only way to cure diseases is to employ methods that will enable the system to throw off these toxic accumulations.^[17] According to naturopathy '*Food is Medicine*'

Wheatgrass juice is nature's finest medicine having antioxidant properties.^[18] It is a rich source of nutrients like vitamins, minerals, enzymes and amino acids.^[19] It works as a health enhancer and is better than synthetic vitamins and supplements. Wheatgrass juice is a rich source of chlorophyll, helps in cleansing body and in neutralizing its toxins, it is a natural detoxifier.^[20] The advocates of naturopathy strongly recommend consumption of wheatgrass to treat various diseases. Antioxidants helps to neutralize the adverse effects of free radicals. Wheatgrass juice is proved to have antioxidant and immunomodulatory effect^[21], which can alter blood sugar levels by improving sensitivity in insulin receptors. Individuals may be more prone to insulin resistance and diabetes with weight gain if they have been malnourished *in utero*.^[22] These associations only applied to infants born of mothers without gestational diabetes. These associations support a role for prenatal nutrition in type 2 diabetes.^[23] Investigators have also considered the possibility that factors other than fiber that are contained in cereals and legumes may influence the risk for chronic diseases.^[24]

METHOD OF STUDY

Study design: Interventional pre-post Test without control

Sample size- 30

Study period -18 months

Intervention period- 1 month

INCLUSION CRITERIA

- Patients of both sexes between age group 40-70 years.
- Patients either having Fasting Blood Sugar range from 126 to 160 mg/dl or Post Prandial Blood Sugar range from 200 to 260 mg/dl.
- Patients not having other serious systemic illness.

- Patients with written informed consent.

EXCLUSION CRITERIA

- Patients with juvenile diabetes (maturity onset).
- Patients with gestational diabetes.
- Lactating mothers.
- Patients having diabetic complications like neuropathy, nephropathy, retinopathy.
- Patients undergoing multidrug therapy.
- Patients on insulin and other diabetic medications.

INTERVENTION PROCEDURE

50 ml of wheatgrass juice mixed with 50 ml water was administered to the patients half an hour before morning food and half an hour before dinner for 30 days.

DO'S AND DON'TS FOR THE PATIENTS

- Patients were advised for brisk walking for 15 minutes daily for 30 days.

Don'ts

- Patients were advised to avoid sweets, sugar, cold drinks, potato, turnip and beetroot.
- Fruits like mango, jackfruit, custard apple, grapes, dates, banana, chiku were advised not to take.
- Patients were advised not to take saturated fats and cholesterol rich diet.

Lab investigations

- Blood Sugar levels - FBS, PPBS
- Urine Sugar
- Urine albumin level
- Urine microscopy

Criteria for assessment

Based on subjective criteria

- Polyphagia
- Polydipsia
- Polyuria
- General weakness

Assessment

The cases were assessed on 0th day, 15th day, 30th day. And follow up on 45th day was assessed. Proforma used for the assessment is given in the annexure 2.

Withdrawal Criteria

In the present study, none of the patients were reported to have allergy or any kind of side effects with wheatgrass juice during the intervention period and none of the patients were reported with FBS greater than 160 mg/dl or PPBS greater than 260 mg/dl during the intervention period.

Hence none of the patients were withdrawn from the study.

Statistical Analysis

Paired 't' Test and Wilcoxon signed-rank Test.

RESULTS

Data Relating to the Effect of Intervention

S. NO.	ASSESSMENT PARAMETER	MEAN			% OF IMPROVEMENT			P –VALUES		
		BT	AT	AF	BT	AT	AF	BT	AT	AF
1.	<i>Polyphagia</i>	0.7	0.3	0.5	--	57.14%	66.66%	--	<0.01 (0.002367)	0.063543
2.	<i>Polydipsia</i>	0.9	0.4333	0.5667	--	51.85%	30.77%	--	0.000982	0.220483
3.	<i>Polyuria</i>	0.6333	0.3333	0.4667	--	47.36%	40%	--	0.00839	0.157014
4.	<i>General weakness</i>	0.8	0.4667	0.4667	--	41.667%	41.667%	--	0.005477	1.041802

The wheatgrass juice intervention was found to be high significant on polyphagia, polydipsia, polyuria general weakness.

S. NO.	ASSESSMENT PARAMETER	MEAN			P Value			SD		
		BT	AT	AF	BT	AT	AF	BT	AT	AF
1.	<i>Fasting Blood Sugar Level</i>	145.60	141.57	143	--	<0.01	>0.05	--	5.05	4.34
2.	<i>Post Prandial Blood Sugar Level</i>	233.133	222.233	215.6	--	<0.05	<0.05	--	21.71	16.82

The wheatgrass juice was effective in reducing FBS level and was high significant after treatment. On follow up the result was not sustained in FBS level and PPBS level was significant after the treatment and during follow up.

S. NO	ASSESSMENT PARAMETER	MEAN			SD			% RELIEF IN SYMPTOM		
		BT	AT	AF	BT	AT	AF	BT	AT	AF
1.	Urine Sugar Level	0.2667	0.1333	0.1333	0.4497	0.3457	0.3457	--	50 %	50 %
2.	Urine albumin level	0.2333	0.0667	0.0667	0.4302	0.2537	0.2537	--	71.4 %	71.4 %
3.	Urine pus cells	0.3	0.1	0.1	0.4661	0.3051	0.3051	--	66.66 %	66.66 %
4.	Urine Epithelial Cells	0.3667	0.1333	0.1333	0.4902	0.3458	0.3458	--	63.6 %	63.6 %

The wheatgrass juice was effective in reducing urine sugar, urine albumin, urine pus cells, urine epithelial cells during treatment, after treatment and in follow up.

DISCUSSION

Wheatgrass juice contains enzymes, minerals, chlorophyll, vitamins and amino acids. It has vitamin A (beta-carotene), vitamin C, vitamin E and vitamin K and B-complex vitamins. It is a source of magnesium, potassium, zinc, calcium, iron, selenium and copper. It contains amino acids alanine, arginine, and phenylalanine. It also contains dietary fibers and biotin.

Diabetes mellitus is a group of metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The hyperglycemia of diabetes increases the risk of a variety of complications. Type 2 DM is characterized by a combination of a defect in insulin secretion and insulin resistance at the site of insulin action in the muscle, liver and adipose tissue. Obesity itself causes some degree of insulin resistance. Diabetes mellitus is also characterized by oxidative stress, inflammation and insulin resistance.

Obesity, Insulin Resistance and Inflammation(William T.Cefalu)

Insulin affects cells through binding to its receptor on the surface of insulin-responsive cells. Insulin resistance of glucose in skeletal muscle is seen in both obesity and type 2 diabetes mellitus. The effect of nutrition and being sedentary on body composition and metabolic fitness are becoming the burden of insulin resistance in no obese with visceral adiposity.

Metabolic alterations in obesity related to diabetes causes defects in intracellular glucose transport, increases the lipolytic response to catecholamine and reduction of hepatic insulin clearance leading to hyperinsulinemia. Inflammatory cytokines by enlarged adipocytes also alter the insulin action.

Inhibition of insulin receptor signaling pathways is a central mechanism through which inflammatory and stress responses mediate insulin resistance. Due to increased delivery of glucose to adipose tissue, endothelial cells in the fat pad may take up increasing amounts of glucose through their constitutive glucose transporters. Increased glucose uptake by endothelial cells in hyperglycemic conditions causes excess production of ROS (reactive oxygen species) in mitochondria, which inflicts oxidative damage and activates inflammatory signaling cascades inside endothelial cells. Endothelial injury in the adipose tissue might attract inflammatory cells such as macrophages to this site and further exacerbate the local inflammation. Hyperglycemia also stimulates ROS production in adipocytes, which leads to increased production of proinflammatory cytokines.¹³

Wheatgrass juice intervention

Medical nutrition therapy and lifestyle changes is important in preventing diabetes, managing diagnosed diabetes and slowing the rate of the development of complications.^[14] Having antioxidant activity- Wheatgrass contains vitamin A (beta- carotene), vitamin C and vitamin E (alpha-tocopherol), which are known natural antioxidant. It has a neuroprotective role because its treatment ameliorated the oxidative damage of rat sciatic nerves in diabetic neuropathy by increasing the antioxidant enzymes SOD, catalase, GSH and decreasing the formation of TBARS (thiobarbituric acid reactive substances).

Significant decrease in FBS and PPBS may be explained by the fact that wheatgrass contains vitamin C. It is documented that there is an increased production of damaging free radicals in type 2 DM patients. Glucose auto-oxidation, protein glycosylation, formation of advanced glycation end products, polyol pathway are involved in generation of oxidative stress implicated in the origin of diabetes. The protection against such damage can be offered by free-scavenging antioxidants.

Wheatgrass action due to nutrients-Diabetes mellitus is believed to be a state of increased oxidative stress. Although antioxidant nutrients appear to play a role in reducing oxidative stress and possibly in insulin sensitivity. Wheatgrass contains selenium. Dietary selenium is another potentially important antioxidant because of its importance in the functionality of glutathione peroxidase.

Increased demand for vitamin C to compensate the increased oxidative stress and impaired transport or dietary deficiency of vitamin C may be contributing to decreased levels of plasma vitamin C as observed in type 2 DM patients.

Another study shows that Vitamin C may improve glycemic control, lowering blood sugar. The improvement of glycemic control was mainly initiated by a beneficial effect of antioxidant on beta cells and may have exerted an influence on target tissues other than the beta cells such as muscle and fat. Antioxidant treatment has beneficial effects on preservation of beta cell function in diabetes, although the effects may not be exerted totally through its direct action on beta cells. Also, regardless of the influence on insulin sensitivity, the antioxidant treatment indeed reduced blood glucose levels. Hence, vitamin C reduced glucose toxicity and contributed in part to the prevention of a decrease of beta cell mass and insulin content.

Another explanation for reduction of blood glucose level is that plasma vitamin C levels seem to play a role in the modulation of insulin action in diabetic subjects. Vitamin C- mediated increase in insulin action is mainly due to an improvement in non-oxidative glucose metabolism.^[25]

Wheatgrass juice contains Magnesium.^[26] Magnesium levels remain remarkably constant in people without diabetes, because of regulatory mechanisms. However, those with diabetes appear to be prone to low serum magnesium levels.^[27]

Magnesium is intimately involved in a number of important biochemical reactions, particularly processes that involve the formation and use of high-energy phosphate bonds. As a cofactor in more than 300 enzyme reactions, it modulates glucose transport through membranes and is a cofactor in several enzymatic systems involving glucose oxidation.^[28] Some believe that magnesium deficiency may increase or cause insulin resistance.^[29] Magnesium depletion in a few studies has been shown to result in insulin resistance as well as impaired insulin secretion and thereby may worsen control of diabetes.^[30]

Magnesium supplementation improves insulin sensitivity as well as insulin secretion in patients with type 2 diabetes mellitus.^[31] Great benefit may lie in patient group with impaired glucose tolerance or beginning type2 DM, improving insulin sensitivity by augmenting

magnesium intake may decrease or retard the occurrence of these abnormalities in glucose metabolism.

Wheatgrass contains Vitamin K, which may be the reason for the reduction in blood glucose level, supporting that vitamin K supplements may improve glucose metabolism, insulin sensitivity.^[32] Vitamin K₁ (Phylloquinone) and Vitamin K₂ (Menaquinones) supplements may help reduce the risk of diabetes by improving insulin sensitivity and glucose metabolism, and hence may be the reduction in glucose levels.^[33]

Wheatgrass contains Zinc.^[34] The trace element zinc also might have played a significant role in the insulin cycle. It is a component of insulin and is necessary for the storage and effect of the hormone. Zinc is furthermore a component of many important enzymes which are involved in the regulation of the glucose balance in the body. Zinc concentrations in the erythrocytes in type 2 diabetic patients is reduced, which seems to be related to the high osmotic fragility of erythrocytes resulting in oxidative stress. Since wheatgrass has healing effects on RBC membrane damage (sudhakar malla)^[50] and it also contains zinc, hence oxidative stress might have improved, so in diabetic patients it might have activated insulin production and hence blood sugar level stabilized.^[35]

Wheatgrass contains Arginine^[36] amino acid, a well-received study from 1998 showed that arginine can reduce insulin resistance. Arginine is a precursor of nitrogen oxide, a transmitting substance which has a direct influence on insulin sensitivity. Arginine can reduce insulin resistance, meaning in turn that insulin sensitivity can be increased.^[37]

Wheatgrass contains B-Complex vitamins.^[38] It contains vitamin B₁ (thiamine), which acts as a coenzyme for transketolase (Tk) and for the pyruvate dehydrogenase and alpha-ketoglutarate dehydrogenase complexes, enzyme which play a fundamental role for intracellular glucose metabolism by increasing Krebs cycle activity. It is demonstrated that thiamine prevents the activation of the biochemical pathways induced by hyperglycemia in diabetes mellitus.^[39]

Wheatgrass contains vitamin B₂. B₂ (riboflavin) is proven to have ameliorative effect on hyperglycemia, oxidative stress was observed with an increased glucose uptake in skeletal muscles and white adipose tissue, and cellular DNA damage was also recovered in type 2 diabetic. Histological studies showed recovery in the liver and kidney tissue injury.^[40]

The wheatgrass juice effectiveness in reducing blood glucose levels may be due to the presence of bioactive constituents like phenols, flavonoids and others. During germination they are synthesized and reach the maximum antioxidant potential.

Wheatgrass has Biotin. Biotin Stimulates the production of compounds like insulin that regulate blood sugar and inhibits the synthesis of enzymes responsible for stimulating the liver to produce glucose. The article also reported that people who do not consume enough biotin are more likely to have impaired glucose tolerance and higher blood glucose levels.

Wheatgrass is one of green substances that are esteemed by wellbeing of people as an incredible source of nutritious supplements. Wheatgrass is having fundamental vitamins and supplements that keep mind and body solid and energetic. Wheatgrass is shown to have anti-inflammatory, immunomodulatory and antioxidant activity. Wheatgrass has healing effect on RBC membrane damage. The extracts of wheatgrass were found to possess anti-microbial property.

Fasting blood glucose is determined by the overproduction of glucose from the liver and the body's ability to remove glucose from the bloodstream. Blood glucose concentration following meal is determined by the rate of appearance of glucose into the bloodstream and its clearance or disappearance from the circulation.

Patients with diabetes require from 3 to 4 hours for blood glucose to return to fasting or pre-meal levels after eating. Factors that affect glucose removal from the circulation such as insulin response or insulin sensitivity can modify the blood glucose levels.

In this study, antioxidant, immuno-modulatory, anti-microbial and anti-diabetic activity of wheatgrass juice might appeared to have played a role in reducing oxidative stress and might possibly in insulin sensitivity and hence may be due to them, the reduction in blood glucose levels and its further reduction in sign and symptoms of type 2 diabetes mellitus.

Wheatgrass is cornucopia of vitamins, minerals and amino acids which synergistically might had improved glucose metabolism and hence may be due to them the reduction in blood glucose levels. Nutrition intervention in the form of wheatgrass juice is the key component of type 2 diabetes mellitus management. Wheatgrass is a safe alternative, cost effective and can be easily cultivated in homes with minimal efforts, because western approach for diabetes mellitus is based on treating hyperglycemia with hypoglycemic synthetic drugs without

caring to correct the metabolic impairments, which is something like applying dye to the grey hair which though helps to look younger does not reverse the fundamental process of senescence.

CONCLUSION

Conclusion is the last main division of a discourse, usually containing a summing up of the points and a statement of opinion or decisions reached. The findings and observations during the present study lead to the following conclusions.

- Wheatgrass juice is effective in reducing fasting as well as post prandial blood sugar in type 2 diabetes mellitus patients.
- Wheatgrass juice is effective in reducing the symptoms of polyphagia, polydipsia, polyuria and general weakness.
- Wheatgrass juice is effective in reducing urine sugar, urine albumin and urine pus cells and urine epithelial cells.
- No adverse effects were observed during study period.
- The intervention was effective in reducing sugar levels as well as signs and symptoms in type 2 diabetes mellitus, which was found to be highly significant. Hence the Null hypothesis is rejected and Alternate hypothesis accepted.

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