International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Multigrain Healthy Cookies for Diabetes Mellitus

Laveena M Tahilramani[1], Rupali Sengupta[2]

[1]Student (MSc CND-2), Department of Clinical Nutrition and Dietetics, Dr. BMN College of Home Science, NAAC-Re-Accredited „A" Grade with CGPA 3.64/4 (Affiliated to SNDT Women"s University Mumbai), 338, R.A. Kidwai Road, Matunga (E), Mumbai: 400019, Maharashtra, India

Abstract: ***Diabetes mellitus (DM) is a metabolic disorder resulting from a defect in insulin secretion, insulin action, or both. Insulin deficiency in turn leads to chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism. Recent reports show strikingly high prevalence of diabetes among urban Asian Indians and abdominal obesity and physical inactivity were found as the risk factors associated with diabetes . The dietary intake of water-insoluble and water-soluble fiber was inversely associated with insulin resistance. A low-fat, high-fiber diet promoted weight loss in patients with type 2 diabetes without causing unfavorable alterations in plasma lipids or glycemic control. A High fiber and low fat diet was found to improve the metabolic control in Type II diabetes. Thus Dietary fat and fibre intake are significant predictors of sustained weight reduction and progression to type 2 diabetes. The objective was to modify a product ie traditional cookies which was high in fats and low in fibers into the modified product ie Multigrain Healthy cookies. in order to improve its fat and fiber content. The modified product contains multigrain flours, vegetables, almonds, sesame seeds and functional foods like black pepper, flax seeds.. A sensory evaluation was conducted after the product was modified by using a 5 point rating scale for analyzing the modified product. On comparison it was found that multigrain healthy cookies were low in fats and high in fibers as compared to the traditional cookies which were high in fats and low in fibers and thus can be beneficial for diabetic subjects for better glycemic control.***

Keywords: diabetes, metabolic disorder, dietary fiber, low fat diet, functional foods

1. Introduction

Diabetes mellitus describes a metabolic disorder characterized by chronic hyperglycemia with disturbances of carbohydrate,. fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. The characteristic symptoms seen are polyuria, polydipsia, polyphagia, blurring. weight loss, fatigue, tingling sensation or numbness in the hands or feet, blurred vision, frequent infections, slow-healing of wounds. The effects of diabetes mellitus include dysfunction and failure of various organs and the long–term effects include progressive development of the specific complications of retinopathy, nephropathy, neuropathy with risk of foot ulcers, amputation, Charcot joints, and features of autonomic dysfunction. According to the Diabetic Atlas 2006 published by the International Diabetic Federation the number of people with diabetes in India currently around 40.9 million is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken. (1) Increasing incidence of diabetes mellitus is mainly due to modern life style and changed diets with balance titled towards refined foods especially sugar and fat. In people with strong genetic factor, environmental factors such as excessive intake of food especially sugar, obesity and lack of exercise act as precipitating agents. The marked increase in the prevalence of overweight and obesity was responsible for the recent increase in the prevalence of Non-insulin dependent diabetes mellitus. Inactivity and alcohol consumption are other dominant risk factors for development of type 2 diabetes. (2)

Cookie is a snack item. It originally contains refined flour, sugar, butter. As health is a major concern, in our day-to-day life, nutritious and health beneficial products are on high demand. Keeping this in mind, a new innovative idea of making a Multigrain Healthy Cookie was introduced. Multigrain flours, vegetables and functional foods are the main ingredients of the recipie. The multigrain flour includes flours of wheat, jowar, bajra, ,ragi. Vegetables like spinach, carrot, ridge gourd was used to increase nutritive value of the cookies. Functional foods like flax seeds, sesame seeds and black pepper was used which are beneficial for diabetes. The traditional cookies was modified to have a low fat and improved fiber content The multigrain cookies was thus a healthier snack option than the traditional cookies.

2. Literature Survey

A study on Prevalence of diabetes, impaired fasting glucose and insulin resistance syndrome [IRS] in an urban Indian population was done and it was observed that subjects with diabetes as well as IRS have greater prevalence of obesity, central obesity, hypertension, hypertriglyceridemia and low HDL as compared with normal subjects. **(3)**. A low-fat, high-fiber diet promoted weight loss in patients with type 2 diabetes without causing unfavorable alterations in plasma lipids or glycemic control. **(4)**. A study on the effects of diet differing in fat, carbohydrate, and fiber on carbohydrate and lipid metabolism in type II diabetes was done and it was found that High fiber and low fat diet was found to improve the metabolic control in Type II diabetes. **(5)**. Dietary fat and fibre intake are significant predictors of sustained weight reduction and progression to type 2 diabetes. **(6)**

A high intake of dietary fiber, particularly of the soluble type, above the level recommended by the ADA, improves glycemic control, decreases hyperinsulinemia, and lowers plasma lipid concentrations in patients with type 2 diabetes. **(7)** The dietary intake of water-insoluble and water-soluble fiber was inversely associated with insulin resistance. A study studied the association of digestible carbohydrates, fiber intake, glycemic index, and glycemic load with insulin sensitivity (S_I), fasting insulin, acute insulin response (AIR), disposition index, BMI, and waist circumference. No association was observed between glycemic index and S_I,

fasting insulin, AIR, disposition index, BMI, or waist circumference after adjustment for demographic characteristics or family history of diabetes, energy expenditure, and smoking. In contrast, fiber was associated positively with S_I and disposition index and inversely with fasting insulin, BMI, and waist circumference but not with AIR. Thus Carbohydrates as reflected in glycemic index and glycemic load may not be related to measures of insulin sensitivity, insulin secretion, and adiposity and Fiber intake may not only have beneficial effects on insulin sensitivity and adiposity, but also on pancreatic functionality. **(8)**. A study to examine the associations of dietary glycemic load, glycemic index, and fibers with plasma adiponectin levels was conducted and it was observed that diets low in glycemic load and high in fiber may increase plasma adiponectin concentrations in diabetic patients. **(9)**

3. Benefits of the Modified Product

Flax Seeds

The effects of ingestion of flaxseed gum on blood glucose and cholesterol, in type 2 diabetes were evaluated. Flaxseed gum was incorporated in wheat flour chapattis. Sixty patients of type 2 diabetes were fed a daily diet for 3 months, along with six wheat flour chapattis containing flaxseed gum (5 g), as per the recommendations of the American Diabetic Association. The control group (60 individuals) consumed an identical diet but the chapattis were without gum. The blood biochemistry profiles monitored before starting the study and at monthly intervals showed fasting blood sugar in the experimental group decreased from 154±8 mg/dl to 136±7 mg/dl (P=0.03) while the total cholesterol reduced from 182±11 mg/dl to 163±9 mg/dl (P=0.03). Results showed a decrease in low-density lipoprotein cholesterol from 110±8 mg/dl to 92±9 mg/dl (P=0.02). The study demonstrated the efficacy of flax gum in the blood biochemistry profiles of type 2 diabetes. (10)

A 2007 study in "Public Library of Science One" found that type 2 diabetics who consumed flax seed-derived lignin supplements for 12 weeks had lower average blood sugar levels as determined by the A1C test, a measurement of blood glucose control based on the percentage of hemoglobin in the blood that contains glucose molecules (11)

Other vegetables

A study,concluded that the ethanol extracts of Cucurbitaceae family fruits, cucumber, white pumpkin and ridge gourd has significant antihyperglycemic effects in AIDRs. They also have the capacity to reduce the elevated lipid profiles in AIDRs. Ridge gourd has also significant effects to restore the depressed hepatic glycogen levels in AIDRs. Therefore, we believe that these fruits extracts can be useful, at least as an adjunct, in the therapy of diabetes, a condition in which hyperglycemia and hyperlipidemia coexist quite often. (12)

Almonds

A randomized, controlled trial on the Appetitive, dietary and health effects of almonds consumed with meals or as snacks was done. This was a 4-week randomized, parallel-arm study that entailed consuming almonds (43 g/day) with breakfast (BF) or lunch (LN), alone as a morning (MS) or afternoon (AS) snack. Participants (N=137) with increased risk for type 2 diabetes completed an oral glucose tolerance test (OGTT) and acute-feeding session at baseline, followed by almond consumption for 4 weeks before repeating the OGTT and acute-feeding trials. The results showed that almonds lowered serum glucose responses postprandially but After 4 weeks, anthropometric measurements and fasting blood biochemistries did not differ from the control group. Thus almonds provide post-ingestive metabolic and appetitive benefits and did not increase the risk for weight gain. (13)

Sesame seeds

Sesame contains high levels of natural antioxidants like sesamin, sesamolin and sesamol which prevents fron oxidative free radical damage to a great extent. Sesame is rich in omega-6 ployunsaturated fatty acids. Sesame seeds contain almost 25% of its weight as protein and is also rich in calcium. The results of the study showed that patients with prediabetes and mild to moderate hyperlipidemia treated with sesame extract for 6 weeks are likely to realize positive changes in their lipid profiles and blood glucose levels. Thus, the herbal supplement (SesaVitaTM) may be beneficial for maintaining healthy lipid and glucose levels in patients with prediabetes and mild to moderate hyperlipidemia. **(14)**

4. Methodology

Developing the Food Product (Multigrain Healthy Cookies]

Product modification denotes modifying a food product in order to improve its nutritive value and quality. Product modification involves including ingredients that are beneficial and suitable for that specific condition and deleting the unhealthy ingredients from the traditional recipe in order to make it nutritious. The food product can be modified from a tradtional food product or it can be newly developed. The objective was to modify the traditional cookies into the Multigrain healthy cookies to lower the fat content and improve its fiber content

- The refined flour in the traditional cookies was replaced by multigrain flour [ragi flour, bajra flour, jowar flour, wheat flour] as they are source of complex carbohydrate.
- Vegetables like ridge gourd, spinach, and carrot was added as they are good source of minerals, vitamins and fibers.
- Almonds , flax seeds, sesame seeds was also added. Flax seeds being good sources of omega 3 fatty acid. Sesame seeds are good sources of calcium, magnesium, copper, vitamin B1, zinc and dietary fiber.
- Black pepper powder which has anti diabetic potential was also been added
- The amount of oil was according to the requirement for baking the product

Table 1: Ingredients for traditional cookies

Ingredients	Amount [gm]
Refined flour	30
Sugar powder	12
Butter	15

Table 2: Ingredients for Multigrain Healthy Cookies

Ingredients	Amount [gm]
Wheat flour	10
Jowar flour	10
Bajra flour	10
Ragi flour	5
Ridge gourd	30
Carrot	30
Spinach	10
Sesame seeds	5
Almond ,	2.5
Flax seeds	5
Black pepper	0.5
Salt	To taste
Oil	5

Table 3: Nutritive Value Table For Traditional Cookies

Ingredients	Amount [gm]	Energy [kcal]	Carbohydrate [gm]	Protein [gm]	Fat [gm]	TDF [gm]
Wheat flour	30	100	22	2.7	0.4	3.75
Sugar	12	48	12	-	-	-
Butter	15	100	-	-	12.2	-
	Total	248	34	2.7	12.6	3.75

Table 4: Nutritive Value Table for Multigrain Healthy cookies

Ingredients	Amount	Energy [kcal]	Carbohydrate [gm]	Protein [gm]	***Fat [gm]***	TDF [gm]
Wheatflour	10	33	7.3	0.9	0.13	1.25
Jowar flour	10	33	7.3	0.9	0.13	0.97
Bajra flour	10	33	7.3	0.9	0.13	1.13
Ragi flour	5	17	3.6	0.45	0.06	0.58
Ridgegourd	30	8	1.5	0.39	0.06	0.57
Carrot	30	14	3.06	0.39	0.03	1.32
Spinach	10	4	0.45	0.36	0.05	-
Sesame seeds	5	22	0.43	0.15	2.26	0.05
Almond	2.5gm	*17*	*0.5*	*0.5*	*1.21*	-
Flax seeds	5gm	27	1.44	0.91	2.10	1.36
Oil	5	45	-	-	5	-
	Total	253	32.88	5.85	10.47	7.23

5. Method of Preparation

In a small bowl mix the flax seed powder with water and let it sit for a minute or two until it becomes a gel

⇩

In a big bowl mix the dry ingredients: wheat, jowar, bajra, ragi flour, almond powder, sesame seeds, finely grated ridge gourd, carrot, finely chopped spinach leaves, black pepper and salt

⇩

Add the flax seed mixture and mix thoroughly to combine and knead it like a dough

⇩

Shape into thin cookies and spread them on a greased baking tray and preheat the oven at 180 degree celcius

⇩

Grease the oil over the cookies and bake the cookies at 180 degrees for 20 minutes

⇩

Take them out of the oven allow them to cool before serving.

6. Results and Discussion

The nutritional values of the traditional cookies and Multigrain healthy cookies was obtained, calculated and compared. Calculation with reference to Nutritive value of Indian foods, NIN was done for standardized product and it was compared with the nutritional values of original product.

Certainly Multigrain cookies has lowered the total carbohydrates and fat content as compared to traditional cookies. The traditional cookies is higher in fats than modified cookies. The fats in the traditional cookies are more of saturated fat as it is provided by butter but modified cookies contains fat from olive oil, sesame seeds which provide ω3 andω6 fatty acids. The protein content of the modified cookies was found to be higher [5.85] than the traditional cookies[2.7]. The fiber content of the traditional cookies which was 3.75 was increased to 7.23 in the modified cookies.

Table 5: Comparison between Traditional cookies and Multigrain healthy cookies

Sr no	Nutrients	Unit	Multigrain healthy cookies	Traditional cookies
1	Energy	Kcal	253	248
2	Carbohydrate	Grams	32.88	34
3	Protein	Grams	5.85	2.7
4	Fat	Grams	10.47	12.6
5	TDF	Grams	7.23	3.75

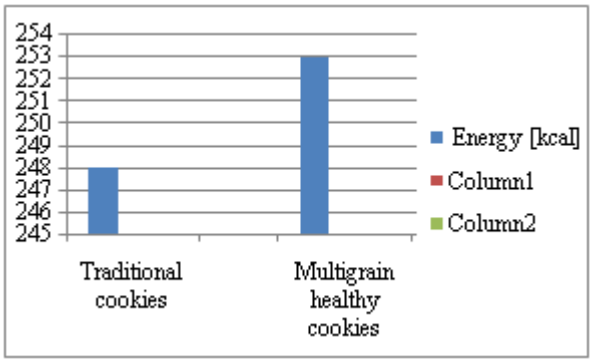


Figure 1: Graph for comparison between energy content of traditional cookies and Multigrain healthy cookies

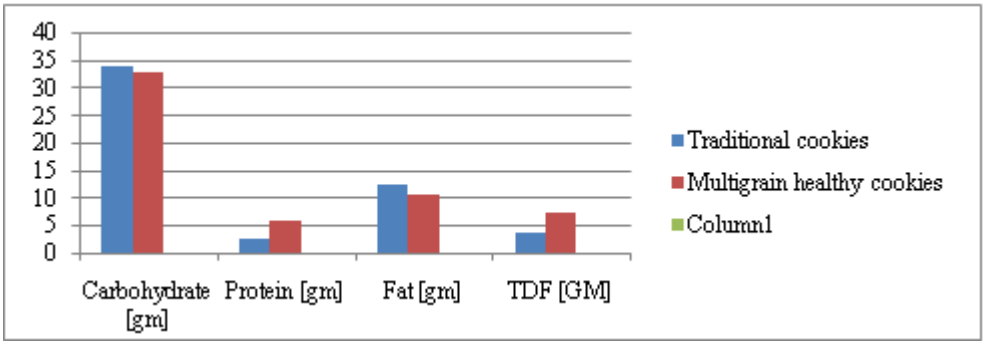
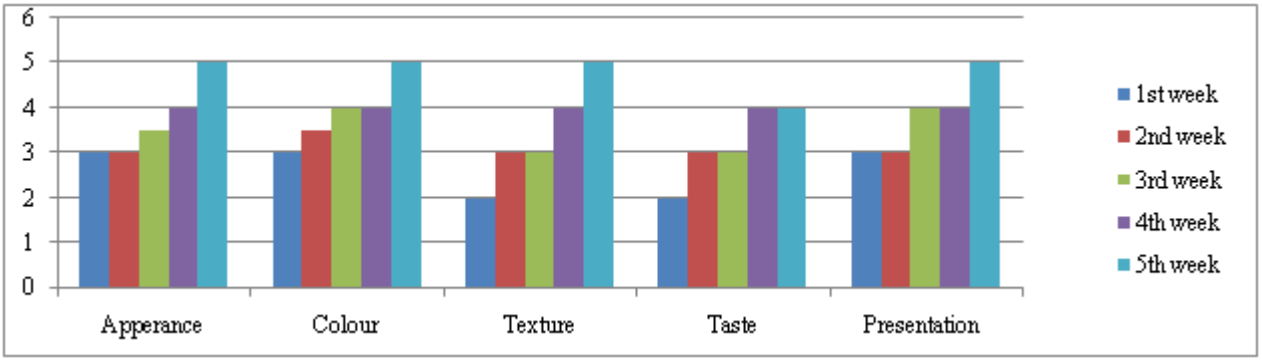


Figure 2: Comparison of nutrients in traditional cookies and Multigrain healthy cookies

SENSORY EVALUATION

Sensory evaluation was done to find the acceptability of the product on the basis of ranking scale. Multigrain healthy cookies were subjected to sensory evaluation based on 5 point scale for Appearance, Color, Texture, Taste, and Presentation. The score was based on the criteria, 5-very good, 4-good, 3-average, and 2-poor, 1-very poor. This test was done by 30 naïve panel members and 3 expert panel members. The product showed a gradual improvement from week after week. The product which was made by keeping diabetic patients in mind was accepted by all the panel members and experts as well. Initially the product was marked as "very good" and later it was marked as "Excellent" with the help of 5 point rating scale method**.**

Graph of sensory evaluation



7. Discussion

In a randomized, crossover study, we assigned 13 patients with type 2 diabetes mellitus to follow two diets, each for six weeks: a diet containing moderate amounts of fiber (8 g of soluble fiber and 16 g of insoluble fiber), as recommended by the American Diabetes Association (ADA), and a high-fiber diet (25 g of soluble fiber and 25 g of insoluble fiber), containing foods not fortified with fiber (unfortified foods). Both diets, had the same macronutrient and energy content. The effects of the two diets on glycemic control and plasma lipid concentrations was compared. The results were found that the high-fiber diet lowered the area under the curve for 24-hour plasma glucose and insulin concentrations, which were measured every two hours, by 10 percent (P=0.02) and 12 percent (P=0.05), respectively. The high-fiber diet reduced plasma total cholesterol concentrations by 6.7 percent (P=0.02), triglyceride concentrations by 10.2 percent (P=0.02), and very-low-density lipoprotein cholesterol concentrations by 12.5 percent (P=0.01) Thus it was concluded that a high intake of dietary fiber, particularly of the soluble type, above the level recommended by the ADA, improves glycemic control, decreases hyperinsulinemia, and lowers plasmalipid concentrations in patients with type 2diabetes. **(15)**

Sesamum indicum may have brought about hypoglycaemic action through stimulation of surviving ß-cells of islets of Langerhans to release more insulin. This was clearly evidenced by the increased levels of plasma insulin in diabetic rats treated with Sesamum indicum. Since the percentage fall in plasma glucose levels was different in models with varying intensity of hyperglycaemia, it implies that the antihyperglycaemic effect of that plant is dependent on the dosage of diabetogenic agent, which in turn leads to ß-cell destruction. Treatment with Sesamum indicum and glibenclamide increase insulin secretion, which, in turn, activates the glucokinase, thereby increasing utilization of glucose and this leads to decreased blood sugar level. The standard drug, Glibenclamide has been used for many years to treat diabetes, to stimulate insulin secretion from pancreatic β-cells. **(15)**

Results of a 12-week randomized crossover clinical trial suggested that incorporation of almonds into a healthy diet has beneficial effects on adiposity, glycemic control, and the lipid profile, thereby potentially decreasing the risk for cardiovascular disease in patients with type 2 diabetes mellitus. (16)

Flax seeds not only are high in alpha linolenic acid (omega 3 fatty acid) but also in fiber, lignans and micronutrients. Flax seeds have shown to improve fasting blood sugars triglycerides, cholesterol and hemoglobin A1c in diabetic patients. American Diabetic Association recommends intake of moderate amounts of flax seeds in the diet. Flax lignan

complex and secoisolariciresinol diglucoside (SDG) have a great potential for reducing the incidence of type 1 diabetes and delaying the development of type 2 diabetes in humans. (17)

8. Conclusion

Diabetes being an alarming condition in India needs a healthy and nutritious diet. Keeping the status in mind, Modified cookies was made from multigrain flour, vegetables and functional foods. Lifestyle changes, healthy body weight, moderate physical activity, a balanced and nutritious diet can help prevent the development of Diabetes Mellitus. The Multigrain healthy cookies was found to be higher in fiber and protein and lower in fats as compared to the traditional cookies. The modified product also contains good amount of protein, calcium and omega-3 fatty acids, fiber making it beneficial for diabetic patients. Thus the product which is the amalgamation of all these ingredients can be widely suitable for people who are suffering from lifestyle disease.

References

[1] *Epidemiology of type 2 diabetes: Indian scenario.* **Mohan, V, et al.** s.l. : Indian Journal of Medical Research, 2007.

[2] *Prevalence of Diabetes and Associated Risk Factors.* **V. Kavitha, V Saradha Ramadas.** Issue 11, s.l. : International Journal of Science and Research (IJSR) , 2014 , Vol. Volume 3 .

[3] *Prevalence of diabetes, impaired fasting glucose and insulin resistance syndrome in an urban Indian population.* **Arvind Gupta, Rajeev Gupta, Mukesh Sarna, Shweta Rastogi, V.P. Gupta, Kunal Kothari.** Issue 1, s.l. : Elsevier Inc, 2003, Vol. Volume 61.

[4] *Effects of a low-fat diet compared with those of a high-monounsaturated fat diet on body weight, plasma lipids and lipoproteins, and glycemic control in type 2 diabetes.* **Glenn T Gerhard, Andrew Ahmann, Kaatje Meeuws, Martha P McMurry, P Barton Duell, and William E Connor.** s.l. : American Journal of Clinical Nutrition, 2004.

[5] *The effects of diet differing in fat, carbohydrate, and fiber on carbohydrate and lipid metabolism in type II diabetes.* **O'Dea K, Traianedes K , Ireland P , Niall M , Sadler J , Hopper J , De Luise M.** s.l. : Journal of the American Dietetic Association.

[6] *High-fibre, low-fat diet predicts long-term weight loss and decreased type 2 diabetes risk: the Finnish Diabetes Prevention Study.* **J. Lindström M. Peltonen, J. G. Eriksson, A. Louheranta, M. Fogelholm, M. Uusitupa, J. Tuomilehto.** Issue 5, s.l. : Diabetologia, 2006, Vols. Volume 49,.

[7] *Beneficial Effects of High Dietary Fiber Intake in Patients with Type 2 Diabetes* . **Manisha Chandalia, M.D., Abhimanyu Garg, M.D., Dieter Lutjohann, Ph.D., Klaus von Bergmann, M.D., Scott M. Grundy, M.D., Ph.D., and Linda J. Brinkley, R.D.,.** s.l. : The New England Journal of Medicine, 2000.

[8] *Dietary Glycemic Index and Glycemic Load, Carbohydrate and Fiber Intake, and Measures of Insulin Sensitivity, Secretion, and Adiposity in the Insulin Resistance Atherosclerosis Study.* **Angela D. Liese, PHD, MPH1, Mandy Schulz, MSC, MSPH12, Fang Fang, MSC1, Thomas M.S. Wolever, MD, PHD3, Ralph B. D'Agostino, Jr, PHD4, Karen C. Sparks, MSPH1 and Elizabeth J. Mayer-Davis, PHD15.** s.l. : DIABETES CARE, 2005.

[9] *Dietary Glycemic Index, Glycemic Load, Cereal Fiber, and Plasma Adiponectin Concentration in Diabetic Men.* **Lu Qi, MD, PHD12, Eric Rimm, SCD123, Simin Liu, MD, PHD123, Nader Rifai, PHD4 and Frank B. Hu, MD, PHD.** s.l. : DIABETES CARE, 2005.

[10] *Effect of flaxseed gum on reduction of blood glucose and cholesterol in type 2 diabetic patients* . **Goutam Thakura, Analava Mitraa*, Kunal Palb & Dérick Rousseauc.** s.l. : International Journal of Food Science and Nutrition, 2009.

[11] **COILA, BRIDGET.** *http://www.livestrong.com/article/428675-flax-seeds-diabetes/.* [Online] November 2015.

[12] *Hypoglycemic and Hypolipidemic Effects of Cucumber, White Pumpkin and Ridge Gourd in Alloxan Induced Diabetic rats.* **R. Sharmin1, M. R. I. Khan2 , Most. A. Akhter2*, A. Alim3 , M. A. Islam2 , A. S. M. Anisuzzaman2 , and M. Ahmed2.** s.l. : Journal of Scientific Research, 2012.

[13] *Appetitive, dietary and health effects of almonds consumed with meals or as snacks: a randomized, controlled tria.* **Mattes2, S Y Tan1 and R D.** s.l. : European Journal of Clinical Nutrition, 2013.

[14] *The Beneficial Effects of SesaVitaTM on Lipid Profiles and BloodGlucose Levels in Subjects With Prediabetes and Mild-To-Moderate Hyperlipidemia in India* . **Venkateshwarlu4, H. N. Shivaprasad1 M. Bhanumathy1 Ceyhun Tamer G. Sushma1 K. R. Raveendra3 & K.** s.l. : Journal of Food Research, 2013, Vols. Volume. 2,.

[15] *Beneficial Effects of High Dietary Fiber Intake in Patients with Type 2 Diabetes Mellitus.* **MANISHA C HANDALIA, M.D., A BHIMANYU G ARG , M.D., D IETER L UTJOHANN , P H .D., K LAUS VON B ERGMANN , M.D S COTT M. G RUNDY , M.D., P H .D., AND L INDA J. B RINKLEY , R.D.** s.l. : The New England Journal of Medicine, 2000.

[16] *ANTIHYPERGLYCEMIC POTENTIAL OF SESAMUM INDICUM (LINN) SEEDS IN STREPTOZOTOCIN INDUCED DIABETIC RATS* . **S.KRISHNAKUMARI*, P.BHUVANESWARI AND.** s.l. : International Journal of Pharmacy and Pharmaceutical Sciences, 2011, Vol. Volume 4.

[17] *Almond consumption improved glycemic control and lipid profiles in patients with type 2 diabetes mellitus.* **Sing-Chung Li1, Yen-Hua Liu1, Jen-Fang Liu, Wen-Hsin Chang, Chiao-Ming Chen, C.-Y. Oliver Chen.** Issue 4, s.l. : Metabolism Clinical and Experimental, 2011, Vol. Volume 60.

[18] *Therapeutic use, flax seeds and diabetes* . **al, Prasad Kailash et.** s.l. : Current Pharmaceutical Design, 2016, Vol. volume 22.

Author Profile

Laveena Tahilramani, M.Sc in Clinical Nutrition and Dietetics Dr. B.M.N College of Homescience, S.N.D.T University.

Dr. Rupali Sengupta Head of Department Dr. B.M.N College of Homescience, S.N.D.T University