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A Review Study – Effect of Millets on Glucose level and Cholesterol level in Type 2 Diabetes Mellitus Patients

Sangyanshi Srivastava[1], Ayush Kumar[2], Sachin Negi[3]
[1,2,3]*Student, School Of Pharmaceutical Sciences, SGRRU, Dehradun, Uttarakhand*

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ABSTRACT
From the past few decades, the dietary modification in the treatment of a different diseases which indicates the physiological response to a food. However, the present study was reviewed systemically and it was found in the different studies that the daily consumption of different types of millet-based foods may reduce the risk of various disease such as Diabetes particularly Type-II, cardiovascular and so on. Even in few studies it was found that the Korean proso millet also elevates the HDL level along with effect on controlling glucose level. It can be concluded that millets play a vital role in management of type II diabetes, CVD and in various non-communicable diseases.

Keywords– Millets, Diabetes, Non-communicable Diseases, HDL.

I. INTRODUCTION

Millets are group of small seeded grass that mainly found in area having low rainfall. On the basis of size of the grains, millets are of various types such as major millet that includes Sorghum Millet(jowar), Pearl millet (bajra), Sama (Little millet), Ragi (Finger millet), Korra (Foxtail millet) and Variga (Proso millet)[1,5].Millets gotit's significance because of its highly nutritive properties. Apart from this, millets do carry good biological activities such as anti-oxidant, anti-inflammatory and anti-obesity [2]. It contains lesser amount of glucose i.e. low glycemic index and dietary fibers, phytochemicals, non-starchy polysaccharides, phenolic compounds that's why aids in lowering the risk of diabetes as well as helps in maintaining the cholesterol level[1,7].

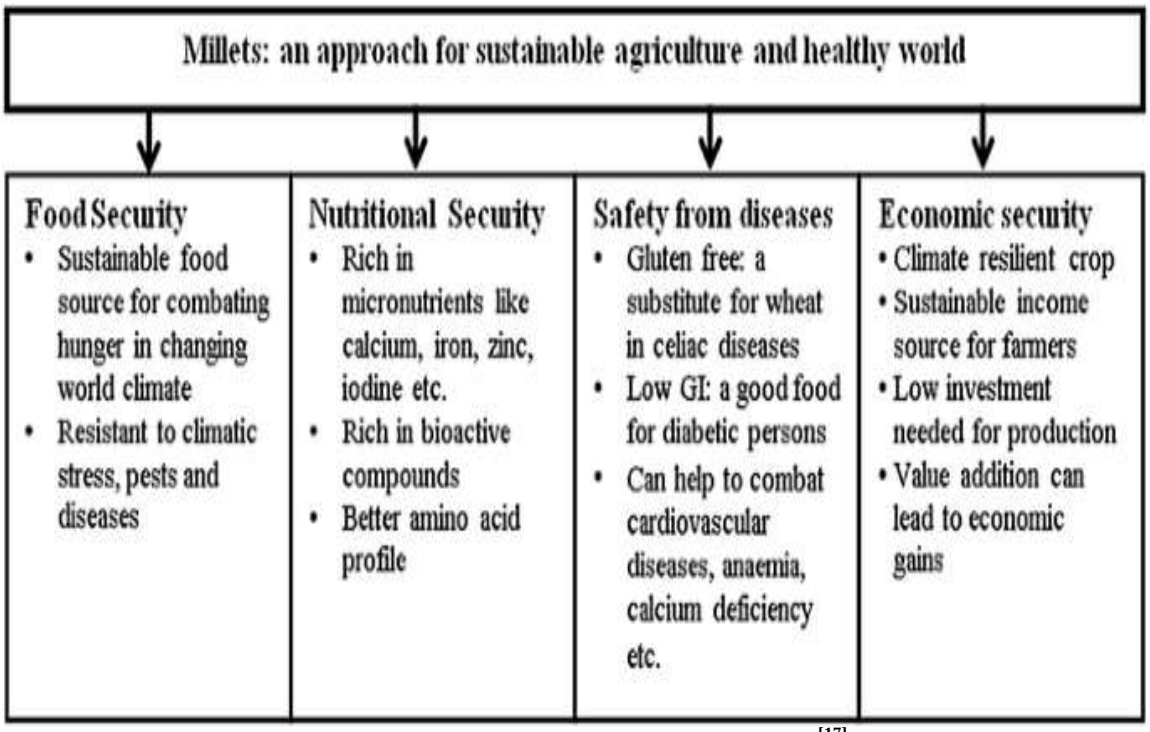

Figure no. 1: Millets as an Asset in human life[17]

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Millets have wide spectrum of pharmacological activities such as antimicrobial, anti-diabetic, anticancer, wound healing, anti ulcerative, antiproteinglycation, aldose reductase enzyme inhibitory property[6,8] . It do contains vitamin B that aids in lysis of carbohydrate and fats and huge amount of fiber in millets which further helps in preventing over-eating and also in the management of weight[7].As mentioned earlier millets do have anti-oxidative property, in studies it is found that antioxidative property is because of the presence of antioxidative phenolic compounds, serotonin derivatives and flavonoids[13]. Millet is also useful in the prevention ageing as it contains phenols and tannins[13]. These nutritive may get alter during the processing of millet, sometimes it get enhanced while sometimes nutritive properties get reduced such as during decortication nutrients get decreased specially minerals and fibers but at the same time the appearance of food get enhanced.

Diabetes and Millets

Diabetes is a complex metabolic disorder characterized by the presence of high glucose level in blood because of increase insulin resistance and found in millions of people throughout the world[2,3,5] . It has a prevelance of 2-4% in India[3]. Diet modification and lifestyle changes are beneficial and effective in the treatment of diabetes[3]. Diet which contains rich amount of fibres and carbohydrates are proven to be ideal for diabetic patient[3]. As, millets have high fiber content and several other nutritive properties so, it aids in lowering the blood glucose level[9]. It also comprises of Magnesium in huge amount which increases the efficiency of insulin and glucose receptors by producing several enzymes[7] .

CVD and Millets

Increase in the level of Total Cholesterol, Triglycerides, Very low density lipoproteins (VLDL), low density lipoprotein (LDL) or decrease in the level of High density lipoprotein (HDL) in blood leads to impairment in the normal physiological functions of body and these abnormal lipids level may also leads to atherosclerosis and coronary heart diseases[10]. Millet contains phenolic compounds which carries anti-oxidant property and that particular property furthur aids in the degradation of low density lipoproteins by inhibiting the peroxidation of LDL, hence preventing the occurrence of dyslipidemia[10]. As described earlier, millets have huge amount of magnesium, it also aids in the prevention of Heart Attack along with diabetes. Moreover, it also contains potassium which act as vasodilator and helps in managing blood pressure and various CVD problems[5].

NUTRITIONAL PROFILE AND COMPOSITION OF MILLETS –

Millets are highly nutritious and serve as a rich source of proteins, fibers, minerals, iron and calcium. It's nutritional value is very high in comparison of wheat and rice[7,8]. It comprises of carbohydrates, proteins, fat, crude fiber, vitamins and minerals and it is a good source of magnesium, manganese, phosphorus, iron, essential amino acids except lysine and threonine and essential fatty acids[5].

Millets comprises of Macronutrients , Micronutrients and Phenolic Compounds.

MACRONUTRIENTS

Millet type	Carbohydrates	Protein	Fat	Crude fibre	Ash	Calorific value
Sorghum	72.97 ± 2.25	10.82 ± 2.45	3.23 ± 1.60	1.97 ± 0.35	1.70 ± 0.66	329.0
Pearl millet	69.10 ± 1.52	11.4 ± 0.8	4.87 ± 0.12	2.0 ± 0.55	2.13 ± 0.21	363.0
Foxtail millet	67.30 ± 5.70	11.34 ± 0.91	3.33 ± 0.76	8.23 ± 1.66	3.37 ± 0.12	352 ± 1.41
Finger millet	71.52 ± 3.59	7.44 ± 0.87	1.43 ± 0.12	3.60	2.63 ± 0.06	334 ± 2.82

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Barnyard millet	56.88 ± 6.86	10.76 ± 1.11	3.53 ± 1.19	12.8 ± 2.4	4.30 ± 0.26	300.0
Proso millet	67.09 ± 4.79	11.74 ± 0.86	3.09 ± 1.18	8.47 ± 3.4	2.73 ± 0.72	352.5 ± 1.62
Kodo millet	63.82 ± 7.94	9.94 ± 1.6	3.03 ± 1.03	8.20 ± 2.3	2.83 ± 0.40	349.5 ± 4.95

Table 1: Content of Macronutrients in different type of Millets[17]

Macronutrients such as Carbohydrates, Proteins, Fats and Crude Fibres enhances the nutritional profile of millets[17]. On an average a typical millet contain 56.88 to 72.97 g/100g of Carbohydrates, 4.76 to 11.70 g/100 g of protein , 1.43 to 6 g/100 g of lipid and 12.8 g/100 g fibres[17]. The high content of fibre makes it a low glycemic food and this aids in the prevention of diabetes mellitus.

MICRONUTRIENTS

Table 2: Content of Micronutrients in different type of Millets[17]

Millets Type	Calcium	Iron	Phosphorus	Zinc	Thiamine	Niacin	Riboflavin
Sorghum	35.23 ± 7.42	5.29 ± 1.28	266.30 ± 32.3	3.01 ± 0.89	0.28	5.19	0.05
Pearl millet	35 ± 8.9	10.3 ± 7.0	339	–	0.30 ± 0.1	1.11 ± 1.3	1.48 ± 1.9
Foxtail millet	31 ± 11	3.5 ± 1.2	300	60.6	0.60	0.55 ± 0.6	1.65 ± 2.2
Finger millet	348 ± 3.5	4.27 ± 0.6	250	36.6 ± 3.7	0.40 ± 0.1	0.80 ± 0.9	0.60 ± 0.7
Barnyard millet	18.33 ± 6.0	17.47 ± 2.0	–	57.45 ± 1.9	0.33	0.10	4.20
Proso millet	10 ± 3.5	2.2 ± 1.2	200	–	0.41	4.54	0.28
Kodo millet	32.33 ± 4.6	3.17 ± 1.3	300	32.7 ± 2.2	0.15	0.09	2.0

Vitamins and Minerals are present in less amount, hence comes under the category of Micronutrients. Minerals such as Calcium, Iron, Zinc, Phosphorus plays an important role in the physiological functions of body such formation of osteocytes, blood formation, transmission of signals, metabolism and synthesis of fats and proteins and aids in several other processes. Minerals content in millets is 1.7 to 4.3 g/100 g[17]. Vitamins, especially Vitamin B is present in millets and enhances immune system and helps to lower cholesterol[5,17].

PHENOLIC COMPOUNDS

Phenolic compounds such as phenolic acids, flavonoids and tannins are present in millets and these helps in reducing postprandial blood glucose levels by inhibiting amylase andα-glucosidase during enzymatic hydrolysis of complex carbohydrates[17]. Millets have antioxidant, anti-mutagenic, anti-oestrogenic, anti-inflammatory, antiviral effects and platelet aggregation inhibitory activity because of the presence of phenols[17].

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Phenolic compound	Pearl	Finger	Proso	Foxtail	Barnyard	Kodo
Hydroxybenzoic acid and derivatives						
Methyl vanillate	19.8	–	–	–	–	–
Protocatechuic acid	11.8	23.1, 48.2	69.7	10.2	–	39.7
p-Hydroxybenzoic acid	22	8.9, 1.7	55.4	14.6, 5.63	–	10.5
Vanillic	16.3, 7.08	15.2,	85.8	87.1, 22.1	–	40.1
Syringic	17.3	7.7	–	93.6	–	–
Gentisic acid	96.3	61.5	–	21.5	–	–
Hydroxycinnamic acid and derivatives						
Caffeic acid	21.3	16.6, 11	–	10.6, 34	–	276
p-Coumaric acid	268.9, 53.5	36	1188	2133.7, 848	–	767
Trans-ferulic acid	637	331	332	631	–	1844
Cis-ferulic acid	81.5	65.3	18.6	101	–	100
8,8′-Aryl ferulic acid	–	–	–	19.6	–	94.8
5,5′-Di ferulic acid	57	11.8	5.44	62.2	–	173
Flavonoids	7.1	1896	1.9	169	–	179

Table 3: Phenolic compound content (µg/g defatted meal) in different types of millets[17]

CLASSIFICATION OF MILLETS

Several types of millets are there such as sorghum millet, pearl millet, finger millet, foxtail millet, proso millet, kodo millet, little millet.

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Sorghum Millet	
Pearl millet	
Finger millet	
Barnyard millet	
Kodo millet	
Little millet	

Table 4 :Types of Millets(Pictorial)[7]

Types of millets are discussed below –

- ✓ **SORGHUM MILLET –** It is proven that sorghum is completely gluten free that's why -+given to those who have gluten insensitivity. Sorghum is rich in Calcium and Policosanols which aids in reducing the blood cholesterol levels[5].
- ✓ **PEARL MILLET** – It is a type of millet which is rich in magnesium and calcium. The presence of magnesium aids in several physiological functions such as helps to reduce the effects of different types of migraine, aids in the prevention of heart attack by maintaining blood pressure, helps in maintaining the glucose level by increasing the insulin sensitivity and the efficiency of glucose receptors[5,7]. Moreover, it is also recommended for asthma patients as it prevents from respiratory problems[5]. The fiber content present in pearl millets prevent the occurrence of gall stones][5].
- ✓ **FINGER MILLET** – It is one of the most nutritious cereals which contains high amount of calcium and iron. Presence of calcium prevents the risk for bone fracturing, so it is recommended for infants, elderly and pregnant women and helps in strengthening bones. While, the presence of iron prevents from anemia and its high fiber content also helps in the prevention of constipation[5].
- ✓ **FOXTAIL MILLET** – This type of millet is also a good source of magnesium , it is also known as Healthy Heart Food[5]. It aids in gradual release of glucose without affecting the normal physiological function and thereby reduces the incidence of diabetes[5].

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- ✓ **PROSO MILLET** – It is a rich source of Vitamin B3 (Niacin) and thereby helps in the management of Pellagra, which is a skin disorder and caused due to deficiency of niacin[5].
- ✓ **KODO MILLET** - It is rich in phytochemiclas and anti-oxidant thereby aids in weight loss and also maintains menstrual cycle in women[5].Furthermore, it is also helpful in reducing different types of joint pain and prevents from different lifestyle related diseases[5].
- ✓ **LITTLE MILLET-**It is a good source of vitamin B , minerals like calcium, iron, zinc, potassium and is highly nutritious. It aids in weight loss by providing essential fats to the body.
- ✓ **BARNYARD MILLET-** It is a good source of protein and has adequate amount of fibres also. However, the carbohydrate content is low. It is most effective in reducing blood glucose level and aids in lowering cholesterol levels.

MECHANISM AND HEALTH BENEFITS OF MILLETS

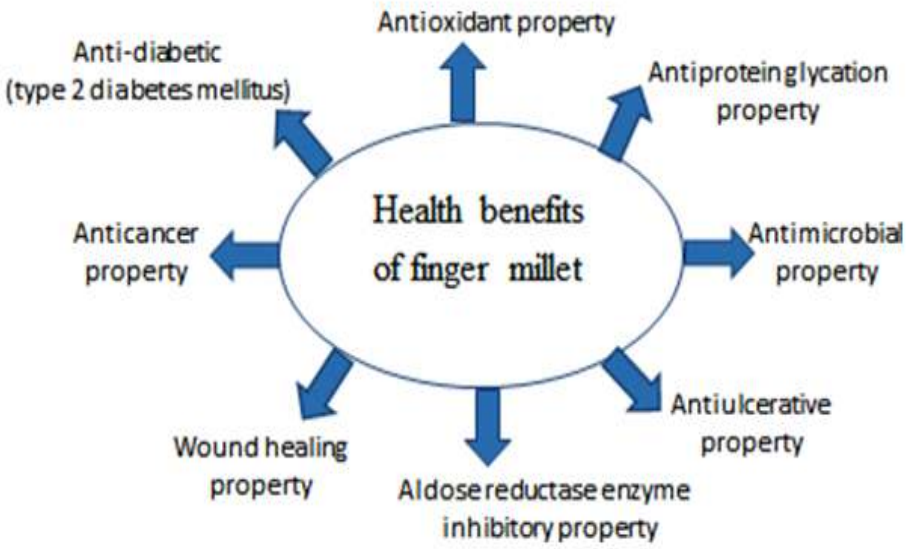

Figure no. 2 – Health Benefits of Finger millet[6]

- ✓ **ANTI-DIABETIC** –Millets are proven to decrease postprandial blood glucose, several mechanism are involve in this[2,5,6,7,8]. One of them is that millets reduce the α-glucosidase and pancreatic amylase which leads to the reduction in the hydrolysis of carbohydrates by these enzymes and that further causes reduction in postprandial blood glucose level[5,7,8]. It is also mentioned that millets prevent sudden spike in the level of blood glucose because of having low glycemic index and gentle stimulation for beta cells of pancreas[2]. The active metabolite of millets modulates glucose induced oxidative stress and inhibit starch digestive enzymes and this helps to lower the blood glucose level[8]. It is also found that millets reduces the insulin resistance and the peak insulin concentration in blood is slightly higher after consumption of millets[9]. Hence regular consumption of millets can decrease fasting glucose as well as insulin resistance[6].
- ✓ **ANTI-LIPIDEMIC** – It has been demonstrated that patient taking millet diet is having lower cholesterol and triglycerides as compared to that of rice and wheat[13]. As millets are good source of magnesium and magnesium reduces the effect of heart attack and migraine also , millets do contain phytic acid which helps in lowering the cholesterol level , it also prevents risk of cardiovascular disease by decreasing the level of triglycerides[12,13]. Millets aids in peroxidation of low density lipoprortein which leads to the degradation of low density lipoprotein and thereby decreases the amount of LDL in blood[10,13].

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- ✓ **ANTI-CANCER** – Millets comprises of Antinutrients such as phenolics, phytate, tannins and these helps in reducing the risk for breast and colon cancer as well as prevent the initiation and progression of cancer[12,13].

- ✓ **ANTI-MICROBIAL** – Millets are found to be effective in inhibiting the growth of fungi such as Rhizoctoniasolani, Macrophomina phaseolina, and Fusariumoxysporum and thereby providing anti microbial activity[12,13].

- ✓ **GASTROINTESTINAL DISORDER** - The fiber content present in millets helps in eliminating disorders like constipation, excess gas, bloating and cramping. Celiac Disease which is triggered by consumption of gluten can be prevented by taking sorghum millet as it is gluten free[18].

II. DISCUSSION

A high intake of millets can improve the glycemic control, hyperinsulinemia and even also lowers the plasma lipid concentration in type 2 diabetes patients and even sometimes in patients with low glycemic index diet. In some studies it has been seen that the whole finger millet dosalowers the peak level of plasma glucose in normal patients[1,3]. Futhurmore, the considerable positive change in glycolipemic parameters may also attribute towards thrfibre content of Foxtail millet as it digested slowly and absorb in the intestine only. Apart from that if millets atre combined with spices used in the diet then it may exhibits the hypoglycemic and hypocholestrolemic when it consumed with diet[1,9].

The variation in the glucose resistant may depends upon the type of millets and upon the different processing methods such as cooking(frying, roasting, steaming, baking and so on), fermentation and gelatinization. For instance, the removal of seed cover may all alter the impact of finger millet. Numerous studies also reveals that the millets reduces blood glucose level and glucose intolerance both in healthy individuals and in type 2 diabetes patients due to its high content of unavailable carbohydrates and high protein content respectively[19]. To elucidate the present finding the further more studies are required to be conducted.

III. CONCLUSION

From the present review article, it can be concluded that the millets elicits positive relationship in the human body but it totally depends upon the variety of the millet consumed and on the type of disease such as the Finger millet and Foxtail Millet have more potential for controlling fasting and post- prandial blood glucose along with plasma insulin resistance in type 2 diabetes patients and even, Finger millet has beneficial effect in some non- communicable diseases(anemia, constipation and so on.). However, the Barnyard millet, Pearl millet and Sorghum Millet have positive impact in the CVS patients and in the gluten insensitive patients.

CONFLICT OF INTEREST

The authors report no conflict of interests.

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