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IMPACT OF PERL MILLET (PENNISETUM GLAUCUM) FOR THE ANTIDIABETIC, ANTIOXIDANT, OTHER BIOMEDICAL APPLICATIONS

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ABSTRACT:

Perl mellitus has become a troublesome and increasingly widespread condition. Treatment strategies for diabetes prevention in high-risk as well as in affected individuals are largely attributed to improvements in lifestyle and dietary control. Therefore, it is important to understand the nutritional factors to be used in dietary intervention. A decreased risk of diabetes is associated with daily intake of millet-based foods. Pearl millet is a highly nutritious grain, nutritionally comparable and even superior in calories, protein, vitamins, and minerals to other large cereals, although its intake is confined to lower income segments of society. Pearl millet contains phenolic compounds which possess antidiabetic activity. Thus, it can be used to prepare a variety of food products for diabetes mellitus. Moreover, it also has many health benefits, including combating diabetes mellitus, cancer, cardiovascular conditions, decreasing tumour occurrence, lowering blood pressure, heart disease risk, cholesterol, and fat absorption rate. Therefore, the current review addresses the role of pearl millet in managing diabetes.

Keywords: Diabetes Mellitus, Pearl Millet, Nutritional Importance, Health Effects

INTRODUCTION:

Pearl millet [Pennisetum glaucum (L.) R Br.] Provides nutritious staple food grains worldwide especially to the poorest rural households in some of the hottest and driest rain fed farming regions of Africa and Asia. Global cereal production has been estimated to increase by ~1 billion tons over the last 50 years (FAOSTAT database, 2017). Pearl millet grown on 33 M ha worldwide is one of the four most important cereals grown in the tropical semi-arid regions of the world. As per Sir Adom, K. K., and Liu, R. H. (2002). Antioxidant activity of grains It has excellent sustainability credentials, as the crop can easily survive on marginal lands, in harsh climatic conditions, and has a short growing season to complete its life cycle. It also is well-suited to multiple cropping systems under irrigated and dry land farming. It contains on average 92.5% dry matter, 2.1% ash, 2.8% crude fiber, 7.8% crude fat, 13.6% crude protein, and 63.2% starch, mostly of the resistant form, and high iron levels. It has a high energy content, lower readily available starch levels, higher fiber (1.2

g/100 g, most of which is insoluble), and 8–15 times greater α-amylase activity compared with wheat. Pearl millet also has a low glycemic index (50) and is gluten-free, thus, an ideal candidate grain for use in the functional-food market worldwide (Ali et al., 2003, Ragaee et al., 2006; Saleh et al., 2013). It also contains several phenolic compounds such as benzoic and cinnamic acid derivatives, anthocyanidins, flavonoids, lignans, and phytoestrogens, which play an important role in disease prevention (Muthamilarasan et al., 2016). As per Sir Alam, M. N., Bristi, N. J., and Rafiquzzaman, M. (2013) Diabetes mellitus is also known as diabetes, a group of metabolic disorders which are characterized by high blood sugar level (hyperglycemia) over a prolonged period of time. globally, the occurrence of diabetes is projected to elevate from 2.8% (in 2000) to 4.4% (in 2030). It might be projected that the number of diabetic patients will increase to over 366 million cases in 2030. It has been well understood that a diabetic patient's glucose level rises exponentially beyond the usual range after a meal. It is also true that the amount of their blood glucose quickly decreases when the body struggles to retain the extra glucose for future use. Types 1 and 2 are classified as diabetes. Type 1 diabetes is also defined as juvenile diabetes or insulin-dependent diabetes as a patient's pancreas is unable to manufacture or produce insulin. However, type 2 diabetes (T2D) usually occurs first in adults whenever the body becomes insulin resistant or fails to deliver enough insulin. T2D accounts for 90% of people with diabetes worldwide. It can mainly be the result of physical inactivity and being overweight. The complication added to T2D is that it has less symptoms reported than type 1 diabetes and is often only diagnosed when side effects have already occurred. Atherosclerosis, which makes the blood vessels hard and narrow, includes major complications caused by hyperglycemia. Heart disease, stroke, retinopathy, and kidney failure are some other diabetes-related health issues. Diabetic retinopathy leads to blindness by cumulatively weakening the tiny blood vessels in the eye, leading to 1% of cases of blindness worldwide. Likewise, a very common complication is kidney failure due to constant restricted blood flow. Increased blood glucose could also cause nerve damage that may lead to the need for amputation of the limb. These disorders decrease the standard of living of the patients and potentially their interaction with others. Increased bone fracture risks in both Type 1 and 2 diabetics are also additional complications .It is however, noteworthy that Types 1 and 2 diabetic individuals have lower and higher mineral densities than stable individuals, while all risk of fractures is high. Other diabetes-related causes may clarify fracturing threats associated with various bone mineral densities. T2D individuals also have a higher body mass index and little physical activity, meaning that every fall is more likely to be fractured .The rise in the body's glucose level physiologically interrupts with glycation, which consequently lowers collagen cross-linking and, despite the higher bone mineral density, results in more brittle bone. In addition, lower bone turnover rates in diabetic patients cause poor fracture healing by interfering with alternate glycaemia with a key bone remodeling regulator, the parathyroid hormone .T2D therefore contributes to a higher fracture risk in many convergent ways. Consequently, fractures further limit patients' mobility, making diabetes worse. Muscle fatigue due to poor glycaemia control is another symptom that a T2D patient would have to tolerate. In turn, this causes fatigue and lack of energy, leading to demotivate patients from participating in physical exercise. Also, as the body derives energy from muscle breakdown, patients lose muscle mass. Such abnormal muscle anabolism makes reduction of muscle mass one of the main risks that a patient with diabetes has to face .The consequent loss of motor function gives the patient's additional physical as well as psychological complications.

MATERIALS AND METHODS:

Pearl Millet Germplasm Association Panel's Genotypes Used:

A random set of 222 genotypes from within the pearl millet germplasm association panel (PMiGAP) was included in this study for antioxidant analysis .The PMiGAP is a collection of genotypes drawn from within the pearl millet core collection, landraces, cultivars, and breeding lines as explained in Sehgal et al. (2015) and represents geographical regions from 23 pearl millet growing countries across the world. The PMiGAP genotypes, thus, included in this study represent the entire global diversity of cultivated pearl millet. Further details of the origin of each of the PMiGAP genotypes used in the study are available in Sehgal et al. (2015) and Varshney et al. (2017). Seeds of each of the PMiGAP genotypes used for antioxidant determination were bulk multiplied by growing them in a uniform field condition following standard agronomic and seed multiplication procedure (Upadhyaya et al., 2008; Ramya et al., 2018). Each entry was planted in three rows by maintaining 15 cm between plants and 75 cm between rows. Field was applied with 100 kg/ha of DAP (di-ammonium phosphate) as basal dose; thinning was done to one plant per hill. Weeding was done two times during the seed multiplication plot. Each individual head was selfed before the emergence of panicle, and strict pollination was controlled to get the pure seeds of each line. Harvesting was done during physiological maturity. Threshing was done with Wintersteiger single head thresher and cleaned to remove the remaining debris.

Preparation of Extracts for Antioxidant Analysis from Pearl Millet Flour:

Pearl millet flour was extracted for antioxidant analysis according to a modification of the method described in Akpanika et al. (2017). A quantity of washed grains (1 g) was milled in a customized robotic instrument (Labmann Automation, Middlesbrough, UK) to obtain a fine flour. Thirty milligrams of flour was extracted with 5 ml of 70% ethanol with intermittent stirring for 1 h. The extract was then centrifuged at 10,000 × g for 10 min at room temperature, and the supernatant was transferred to clean tubes. The pellets were then washed with 2.0 ml of 70% ethanol and centrifuged again at 10,000 × g for 10 min. The second supernatant fraction was added to the first to maximize recovery of target compounds. The ethanol was then removed using a heated centrifugal evaporator (Jouan RC10.22, Saint Herblain, France) set to 70°C. The dried extract was re-dissolved with 70% ethanol to an equivalent concentration of 15 mg/ml of the original sample and stored at 4°C until analysis. All biochemical analyses (see below) were carried out in triplicate, which allowed us to calculate the repeatability of these measurements.

Determination of 1,1-Diphenyl-2-Picrylhydrazyl Radical Scavenging Activity:

DPPH is a stable free radical for the determination of antioxidant or radical scavenging capabilities. The DPPH radical portion of the molecule is a centralized nitrogen atom that gives rise to a maximum absorbance at 515 nm in methanol in its oxidized form. When a solution of DPPH in its radical form is mixed with a proton-donating substance such as antioxidants, the radicals are scavenged, and DPPH=H is formed with a concomitant decrease in absorbance. The ability of the pearl millet ethanolic extracts to scavenge free radicals was determined against a very stable free radical DPPH (1,1-diphenyl-2-picrylhydrazyl). DPPH is violet in color, while the reduced product is colorless, and the loss of color was determined in a plate reader (Hauck, 2018). Aliquots of the sample extract (50 µl) at different concentrations were added to ethanolic solutions of 500 µl of DPPH (0.12 mg/ml). Each mixture was left for 20 min at room temperature in the dark. The absorbance was measured at 517 nm, and the activity was expressed as percentage of DPPH radical relative to control using the following equation: DPPH scavenging activity (%) = [(absorbance of control – absorbance of sample)/absorbance of control] × 100.

RESULTS:

As per Sir Ali, M. A. M., El Tinay, A. H., and Abdalla, A. H. (2003), High-Performance Liquid Chromatography With Online Photodiode Array Detection and Electrospray Ionization–Ion Trap Tandem Mass Spectrometry Analysis. The total phenolics and flavonoid content that resulted from the HPLC-PDA-ESI/MSn is presented which shows the mass spectral data showing identified peaks in the representative chromatograms of the phenolic fractions of the selected millet grains. Phenolic compounds identified in millets were mainly of the flavonoids class, although spermidine hydroxycinnamte conjugates were also detected. Apigenin glycosides were the most prevalent flavones in the germplasm samples, and these included apigenin-8-C-glucoside (AH; Vitexin), apigenin-C-pentoside-C-pentoside (ADP), and apigenin-O-hexoside-C-hexoside (ADH). Luteolin-glycosides were also relatively abundant with luteolin-C-O-dihexosidedihex (LDH), and its caffeic acid conjugate was detected in extracts. The phenolamide, dicaffeoyl spermidine, was also observed in the sample extracts.it demonstrates that apigenin is the predominant flavone in pearl millet samples with high levels of phenols, with the exception of Tift186, while for samples with lower total levels; apigenin is generally the major flavone core. The results also suggest that apigenin levels are far more variable than luteolin content. In millet phenolic extracts, several compounds from different flavonoid groups were detected that were either positively or tentatively identified as flavan-3-ol (monomers and dimers), flavonols, and their glycosides, and flavones, although in the current study, only flavone glycosides were found to be present in quantifiable levels.

CONCLUSION:

As per Sir Akpanika, G. A., Winters, A., Wilson, T., Ayoola, G. A., Adepoju-Bello, A. A., and Hauck, B. (2017), Phytochemical antioxidants have numerous nutritional benefits, especially phenolic compounds, which are an important group of secondary metabolites with bioactive properties (e.g., hydroxycinnamates and flavonoids) and play a significant role in plants and human health conditions such as cancer, diabetes, and heart disease (Chandrasekara and Shahidi, 2011; Ofosu et al., 2020). Pearl millet [Penisetum glaucum (L) R. Br.] is widely cultivated as a dietary staple food in the arid and semi-arid regions of the world, particularly in India and Africa and known to be a good source of natural antioxidants. In the present study, we explored the antioxidant activity in the pearl millet germplasm (PMiGAP) set of 222 genotypes, by screening it for DPPH and FRAP assays. These assays are widely applied in numerous studies to investigate the free radical scavenging ability and for measuring antioxidant activity of natural extracts [Alam et al. (2013), López et al. (2014), and Berwal et al. (2016)]. The phenotypic evaluation and comparison of antioxidant activity in PMiGAP revealed distinct differences among pearl millet lines for antioxidant activities. The majority of pearl millet accessions were found to have higher FRAP activity. On an average, DPPH scavenging activity of 53.8% was observed among the pearl millet germplasm studied in this report. It is generally referred to in various local Indian languages as bajra, bajri, sajje, kambu, kamban, sajjalu, etc. It is widely used for food and forages. Pearl millet is the third largest major crop after rice and wheat in India. It was developed on an area of 7.4 million, averaging 9.13 million tons, in 2017–2018. Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana are the largest pearl millet growing states in the country. The higher nutrient content means that pearl millet has been recognized by the Ministry of Agriculture, Government of India as one millet under "Nutri-Cereals" (GOI). Pearl millet has a higher digestibility of fat than most cereals. It is also rich in unsaturated fatty acids with higher nutrient omega-3 fatty acid content .Pearl millet has a maximum content of macronutrients and is considerably rich in resistant starch and soluble and insoluble dietary fibre in contrast to other millets. Basically, pearl millet has a large root structure, which absorbs soil nutrients and has a higher importance for nutrition than other cereal crops, including wheat, rice, maize, and sorghum. A high degree of iron, zinc, magnesium, copper, manganese, potassium, and phosphorus is found in the mineral. This is a strong energy source with a calorific value of 361 Kcal/100 g and a high amount of fibre (1.2 g/100 g). It is higher and is a healthy source for vitamin B, vitamin A, folic acid, calcium, and magnesium. Pearl millet grain has a higher fat content than other cereals which causes low product quality.

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