Antimicrobial and antidiabetic potentials of processed finger millet (*Eleusine coracana*)

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Abstract

Finger millet is a food crop with energy value, phytochemical constituents, and minerals, hence its use as whole flour for traditional food preparation among traditional people. The study was designed to determine the glycemic index and blood glucose level in albino rats, and the antimicrobial potential of processed finger millets. Finger millets were processed by fermentation and roasting, and methanolic extracts obtained used to test antimicrobial activity. Albino rats (18) divided into three groups were fed fermented, roasted, and unprocessed millet (control), and glycemic index and blood glucose level determined. Another 25 rat were treated into 5 groups of diabetic rats without treatment, diabetic rats treated daily with Metformin, diabetic rats fed 20% millet, diabetic rats fed 40% millet, and untreated group (control). At 100% concentration, roasted and fermented millet obtained inhibition of 15mm and 14mm against *Salmonella typhi*, while the control drug 25mg/ml streptomycin had 17mm inhibition. While values obtained for the glycemic indexes were close though significantly different from each other (roasted - 36.8±1.23; fermented - 38.7±1.87), roasted millet brought about the highest reduction in blood glucose level 90.9 and 65.1mg/dl at 60 and 120min respectively compared with fermented millet with 125.1 and 100.2mg/dl respectively at the same time. Animals administered finger millet in Groups 3 and 4 showed regeneration of the islet cells. The millet had the capacity to bring about healing of necrotic and also restoring and maintaining glucose levels in blood of subjects.

Keywords: Albinos; Antimicrobial; Glycemic; Regeneration; Millet

1. Introduction

African finger millet also known as *Eleusine coracana* is a cereal grown in the arid areas of Africa and Asia. The Hausa call it tamba and the Yorubas call it oka. It is a reservoir of phytochemicals, minerals, anti-nutrients, and important proximate metabolites (Chethan and Melleshi, 2007). The millet could be consumed raw, cooked, or subjected to other processing method such as milling, boiling, and roasting as generally practiced in Nigeria. It can be sustained in good viable condition for many years without treatment, and infestation by insects and pests which makes it a reserve food. Phytochemicals in cereals has potential health benefits, and Aparicio–Fernandez et al. (2005) and Reynoso–Camacho et al. (2006) explained that the seed coat harbours rich fractions of such metabolites. Diabetes mellitus is characterized by hyperglycemia, resulting from insufficient or inefficient insulin secretion, with alterations in carbohydrate, protein and lipid metabolism. It results in deficient insulin production (Type 1) or combined resistance to insulin action and the insulin secretory response (Type 2). Diabetes is a scourge with increasing prevalence among the rich and the poor, urban dwellers are those living the rural areas in developing countries (Colagiguri, 2005). The problem of management of the disease is a frontal challenge for health workers and patients as it alters feeding regimens. A good nutritional plan serves as the cornerstone of any diabetes management, therefore, eating healthy and increased physical activity helps prevent and effectively manage diabetes and related diseases.

Consumption of whole grains, cereals and products provides the primary sources of nutrition and health benefits for diabetics and non-diabetics (Krings et al., 2000). The main difference in dietary requirements of a diabetic and non-diabetic is the regimentation of food intake that constitutes the corner stone of diabetic therapy such as timing of food intake, the caloric value of the food and the proportions and quantity of carbohydrates, fats and proteins which are important aspect of the dietary management for achieving the objectives of diet therapy, and by creating a situation in which the diabetic lives healthy and full lifestyle, with normal longevity (WHO, 2010). Cereals contains high level dietary fibre with health promoting phytochemicals (Bouchenak and Lamri–Senthadij, 2013; Pulse Canada, 2013). Education, communication and knowledge of available locally grown, affordable diet can be used to build strong immunity, helps prevents diseases and specifically manage diabetes mellitus is important. The aim of this work was to determine the glycemic index, blood glucose level in albino rats, and antimicrobial potential of differently processed finger millets.

2. Materials and methods

a) Procurement and processing of finger millet

Commercially available finger millet were obtained and identified at the Herbarium unit of the Department of Biological Sciences, Ahmadu Bello University, and Zaria with a voucher No 24356. The millets were processed by a) roasting for 10 – 15 min in an open
pan b) fermenting by soaking the seed in clean water and covering with a sack for 24 h and then sun-dried.

b) Preparation of extracts
The dried powdered sample were successively extracted from the fermented and roasted grains with methanol in Soxhlet apparatus and stored at 4°C.

c) Test microorganisms
_Bacillus subtilis, Salmonella typhi, Escherichia coli, Shigella sonnei, and Candida albicans_ were the test organisms for the study. The microbes were obtained from the Department of Medical Microbiology, Ahmadu Bello University Teaching Hospital, Zaria, Nigeria.

d) Antimicrobial assay
Antimicrobial susceptibility test was done using modified methods of Perez (1990). Agar well diffusion of the extract was used to determine the antibacterial and antifungal activities of the finger millet. Nutrient agar plates were inoculated with the different test microorganism by spreading the bacterial inoculums under aseptic conditions. Wells of 5 mm diameter were punched in the agar medium with sterile cork borer and filled with extracts. Streptomycin was the positive control for bacteria, while fluconazole was the positive control for fungi.

iii) Induction of diabetes
Diabetes mellitus was induced by administration of a single dose (i.p.) of 55 mg/kg of Streptozotocin, dissolved in 0.1 M fresh cold citrate buffer (pH 4.5) into 12 h fasted rats (Burcelin et al., 1995). After 3 days of STZ post-injection, the blood sugar levels were determined with a glucometer (Accu-check Advantage Roche diagnostics GmbH, Germany). Rats with fasting blood glucose levels >126 mg/dl (11.1 mmol/L) were considered diabetic hence, selected for experimentation.

The remaining 25 animals were divided into 5 groups made of 5 rats each. Group 1: Diabetic rats without treatment (Diabetic control, DC). Group 2: Diabetic rats treated daily with Metformin (2.5 mg/kg body weight) daily (DE+STD DRG) Group 3: Diabetic rats fed with 20% finger millet (DE+20%). Group 4: Diabetic rats fed with 40% finger millet (DE+40%). Group 5: Non-diabetic and untreated (Normal control, NC).

f) Statistical Analysis
Data was analysed by (Analysis of Variance) ANOVA using SPSS 20.0 software. All analysis was carried in [3] replicates. The results were presented as means ± SD of 3 determinations. The means separated using Tukey’s test. Level of significance was set at _P_ ≤ 0.05.

3. Results

a) Processed millet extract inhibition
After 24 h incubation as shown in Table 1, extracts of roasted finger millet gave better activities against _Candida albicans, Salmonella typhi, Escherichia coli, and Bacillus subtilis_ when compared with fermented millet extract. Best inhibition of the microbes was recorded at 100% concentration of the two extracts; and the extracts at the four concentration tested showed the least potency against _Candida albicans_. At 100% concentration, roasted millet inhibited _Escherichia coli_ (16.0 mm) and _Salmonella typhi_ (18.0 mm) more than the positive control at 15.0 mm and 17.0 mm respectively.

Result in Table 2 saw retarding values by the extract of the processed finger millet. While the positive control maintained their inhibition of the microbes after 48 h, the activities of the extracts of the processed millet had declined. Sharp decline in particular noted at 100% concentration in _Salmonella typhi_ and _Escherichia coli_ that had reduced to 15.0 mm and 13.5 respectively for roasted millet, while fermented millet extract had 14.0 mm and 13.0 mm at 100% concentration for the two microorganisms respectively. Positive Control – Streptomycin 25 mg/ml (bacteria) and fluconazole 25 mg/ml (fungi); Negative control – extract of unprocessed finger millet

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<th>Microorganisms</th>
<th>Fermented Finger millet</th>
<th>Roasted Finger millet</th>
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<tr>
<td>Shigella sonnei</td>
<td>15.0</td>
<td>4.0</td>
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<tr>
<td>Candida albicans</td>
<td>13.0</td>
<td>5.0</td>
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<tr>
<td>Salmonella typhi</td>
<td>17.0</td>
<td>7.0</td>
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<td>Escherichia coli</td>
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<td>Bacillus subtilis</td>
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The Control group fed 50 g carbohydrate had the highest glycaemic index of 44.07±1.67, while roasted millet had 36.83±2.23 as the lowest (Table 3). Glycaemic index values obtained for the different processing methods were significant at _P_ < 0.05. Fermented finger
millet brought about the highest blood glucose concentrations 125.1 mg/dl at 60 min. While an increasing trend was observed in all the treatments as time increases, after 60 min, they all started to descend.

Table 3: Concentration of Blood Glucose (Mg/Dl) and Glycaemic Index of Processed Millet Food items 15 min 30 min 45 min 60 min 90 min 120 min Glycaemic index Roasted grain 65.2 75.3 80.0 90.9 70.2 65.1 36.83±1.2 Fermented grain 80.1 84.8 87.1 125.2 110.0 100.0 38.73±1.8 C 74.5 80.6 86.7 92.4 74.3 68.6 44.07±1.6

Means followed by different letters (a, b, c) in the same column differ significantly (P < 0.05); C – Control.

c) Blood glucose concentration in finger millet treated albino rats

As shown in Figure 1, decreasing values were recorded as treatment proceeded for animals in Group 2, 3, and 4 respectively. Diabetic rats not administered any treatment presented no reduction as the study proceeded. Diabetic animals treated with 40 % SCM showed highest reduction in glucose level, while Non-diabetic and untreated animals did not record any significant increase in glucose level throughout the duration of the study.

5. Discussion

The inhibition recorded by the methanolic extract of finger millet not minding the processing method could be ascribed to the presence of antimicrobial metabolites and phytochemicals present in the extracts. Phytochemicals occur naturally in plants depending on growing conditions, age at harvest, extraction methods, and have protective or disease preventing potentials (Anjorin et al., 2013). Phenol, flavonoids, tannins saponin, alkaloids, and anthocyanins are ample in finger millet (Chethan and Melleshi, 2007). Terpenoids from research confers antioxidant, antimicrobial, antifungal, antiviral properties on plants, while phenols are antimicrobial especially against Gram-positive bacteria (Tiwari et al., 2009; Ayoola and Adeyeye 2010).

The result presented in this study agreed with Viswanath et al. (2009) and Xu et al. (2011) who showed antimicrobial activities of extracts and fractions of millet grain against Bacillus cereus and Aspergillus flavus and other microorganisms. Banerjee et al. (2012) showed that phenolic and flavonoids of finger millet could inhibit the proliferation of E. coli, B. cereus, Listeria monocyctogenes, Staphylococcus aureus, Streptococcus pyogenes, Serratia marcescens, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumonia and Yersinia enterocolitica. Roasting from the unpublished report of Aisoni et al. (2018) reduces and removes flavonoid, steroids, and saponin from finger millet and still yielded better inhibitory activity than fermented finger millet. This might be because of roasting reducing the water content of the grains thus making the available phytochemicals more concentrated and more potent.

The glycaemic index is a figure representing the relative ability of a carbohydrates food to increase the level of glucose in the blood. One food gives one glycaemic index value which could vary due to variety, response, cooking methods, processing and the length of
storage. Differences are reported in glycaemic response from person to person, from day to day depending on blood glucose levels, insulin resistance, and other factors. Carbohydrates with low glycaemic index are slowly digested, absorbed, and metabolised and bring about lower and slower rise in blood sugar. Processing finger millet by fermentation and roasting drastically reduce the glycaemic index of the food when compared with the unprocessed millet. Both processing methods are encouraged as they will ultimately reduce insulin levels in the body. Our finding corroborated report by Young (2009) who recommended finger millet preparations for diabetics because of its sustained power and lower glycaemic responses in subjects. Lower glycaemic responses noted in the processed millet might be as a result of the presence of anti-nutritional factors in food products; which are capable of reducing starch digestibility and absorption (Lakshmi et al., 2002). Reports have shown that phytic acid, tannin, oxalic acids, hydroxyacids and saponins which are anti-nutrients have negative effect on animal and human health at high concentrations, these anti-nutrients can be greatly reduce by heating at 100°C (Njoku et al., 2014; Ladeji et al., 1995; Akwaowo et al., 2004; Ajbade et al., 2009). These anti-nutrients have widely distribution in leafy vegetables and cereal crops, and modify effects of other nutrients by reducing bio-availability of the nutrients (Okoro, 1989; Hurrell et al., 1992).

Fermented grain brought about high rise in the blood glucose concentration when compared with roasted grains and food treatment incorporated with 50 g carbohydrate. High glucose level obtained might be as a result of the treatment with fermented millet showed it has little anti-hyperglycaemic activities, while roasted millet brought about glucose concentration which gradually increased to 90.9 mg/dl at 60 min, then decreased to 65.1 mg/dl at 120 min. Findings in this study showed that roasted millet possess higher anti-hyperglycaemic activity. As reported by Scalbert et al. (2005), polyphenols among which flavonoids are known to inhibit glucose absorption and it is absent in roasted millet (Aisoni et al., 2018 unpublished). When compared with other cereals, millet had been reported to bring about the lowest blood glucose, serum cholesterol, and triglycerides compared with other minor millets, while the processing bring about changes in the starch molecule depending on its type and processing employed (Malleshi, 2006; Kumari and Thayumanavan, 1997). Increased observed in the blood sugar level was the result of diabetess induction using 55 mg/kg of Streptozotocin. Streptozotocin bring about liver injury which is the combination of series of metabolic process dysfunction to include DNA damage, disrupted protein synthesis, aberrant inflammatory response, lipid peroxidation, and mitochondrial respiration interference (Sorrenti et al., 2013). Subsequent feeding of rats saw healing as reductions in blood sugar and mitochondrial respiration interference (Sorrenti et al., 2013).

6. Conclusion

The study concluded that roasted finger millet had higher potential at inhibiting microorganisms, though both roasting and fermentation methods reduces glycaemic index in millets and therefore bring about reduction in blood glucose levels. Findings also showed the capabilities of finger millet to ameliorate and bring about healing in the liver and pancreas induced by streptozotocin through the anti-oxidants present in the grain.

References


