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Polyphenol Profile in different Maize varieties and their Antioxidant Potentials: Implications in Disease Resistance

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ABSTRACT: Maize is well known to contain a wide variety of secondary metabolites like polyphenols which play a main role in the protection of disease resistance. In recent times there are many varieties of maize that are available commercially in the markets. In the present study, the main objective was to analyze ten maize varieties for moisture content, total polyphenol content (TPC), their characterization by high-performance liquid chromatography (HPLC), evaluation of their antioxidant potentials, and their aflatoxin production in selected maize varieties. The TPC was estimated by Folin Ciocalteu's reagent (FCR) method, and antioxidant potentials by DPPH assay (2, 2-diphenyl-1-picrylhydrazyl). Maize varieties showed a percent moisture (%M) content of 1.79 -3.02%. The MZ-9 showed 3.02% whereas MZ-2 showed 1.79 %, and the total polyphenol content was found to be in the range of 33 - 190 µg g^{-1} (catechol equivalent). The MZ-7 variety exhibited the highest total polyphenol content (190 ± 0.66 µg g^{-1}) with lowest aflatoxin production (0.446 ± 0.16 µg g^{-1}) whereas the MZ-2 exhibited the lowest (33±0.29µg g^{-1}) and highest aflatoxin production (1.315 ± 0.10 µg g^{-1}). The HPLC analysis of polyphenols in all maize varieties depicted cinnamic and trans ferulic acid as the most abundant polyphenols. The antioxidant assays showed that the MZ-5 variety had the highest activity (79.18%) and MZ-4 had the lowest (62.89%). The present studies reveal the polyphenol profile, antioxidant potentials, and the inherent percent moisture content in the ten different varieties of maize grains (kernels) collected from local regions which may influence their yield (produce) and their resistance to pathogens including toxigenic fungal species such as *Aspergillus, Fusarium,* and *Penicillium*. The antioxidant properties of these dietary polyphenols go beyond oxidative stress and may play an important role in preventing degenerative diseases.

Keywords: Maize, Polyphenol profile, Antioxidant potential, HPLC, DPPH activity.

INTRODUCTION

Maize (*Zea may*s L) is one of the most versatile staple crops having wider adaptability under varied agro-climatic conditions in the context of global nutrition (Nuss *et al.*,2010; Sai Pratyusha *et al.*, 2022). Maize is known as the queen of cereals because it has the highest genetic yield potential among cereals(Parle & Dhamija 2013; Rouf Shah *et al*., 2016a). There is also significant evidence that an adequate intake of cereals, fruits, vegetables, grains, and other herbs has a helpful effect on health and aid in the prevention of various diseases (Ramos-Escudero *et al*., 2012; Slavin & Lloyd 2012). Most cereals are abundant sources of polyphenols and antioxidants including maize (Butts-Wilmsmeyer *et al*., 2018; Priyanka & Sujata 2023). The United States of America (USA) is the largest producer of maize and contributes nearly 35 % of the total production (Parle & Dhamija 2013; Rouf Shah *et al*., 2016a; Muramatti *et al*., 2022). Maize is a source of both nutrition as well as phytochemical compounds. Phytochemicals have an important role in stopping chronic diseases (Liu, 2004; Siyuan *et al*., 2018; Zhang *et al*., 2015; Singh *et al*., 2023). It contains various major phytochemicals such as phenolic compounds, carotenoids, and phytosterols(Pandey & Rizvi 2009; Rouf Shah *et al*., 2016b). The organizational anatomy of maize grain consists of an upper covering called pericarp or hull which plays role in resistance due to fungal infestation (García-Lara *et al*., 2004). Beneath which endosperm is rich in starch content and the middle part is the actual germ or embryo and the innermost part is the pedicel or the flowering stalk. Maize is a staple cereal enriched with abundant amounts of macronutrients like starch, fiber, protein, and fat along with micronutrients like vitamin B complex, ß-carotene, and essential minerals, such as magnesium, zinc, phosphorus, copper, etc. The edible portion of maize is its kernel in which starch is a

primary carbohydrate and amounts to 72% of its dry weight, while protein is 11% and sugar amounts to 1-3% of which sucrose is the chief component and maltose, glucose, fructose, and raffinose are the other components which are mostly present in the germ part with only 25% is there in the endosperm part (Nuss & Tanumihardjo, 2010; Akshay, 2023). Maize also contains high amounts of antioxidants that protect from various degenerative diseases (Aggarwal, 2017; Manach *et al*., 2005; Wootton-Beard *et al*., 2011; Zhang *et al*., 2015; Ghafory *et al*., 2015). Food grains are susceptible to infestation by various fungal species belonging to *Aspergillus*, *Fusarium*, *Penicillium*, etc. are the known pathogens. Among the pathogenic fungi, many of them are toxigenic which produce toxins (mycotoxins) in the food grains they infect. When these contaminated grains are consumed by animals and humans it causes deleterious effects resulting in mycotoxicosis. Maize and groundnut have been reported to be high-risk commodities for fungal infestation and mycotoxin production (Bankole *et al*., 2006). Infestation of maize by *Aspergillus* and its consumption resulted in aflatoxicosis (Probst *et al*., 2014). Consumption of maize infected with *Fusarium* causes human diseases and losses in maize yield also (Bernardi *et al*., 2018; Ferrigo *et al*., 2016). The degree of contamination in these food grains has been reported to be dependent on the nutrient composition and more specifically on the levels of polyphenols present in them (Dai & Mumper 2010). In this regard in maize, variation in polyphenol content has been reported by researchers as one of the protective mechanisms in developing resistance against *Fusarium-based* infections (Bernardi *et al*., 2018). Although earlier studies by Scalbert *et al*. (2005a) reported that consumption of plant foods rich in polyphenols may have a protective effect on disease resistance in humans, they are based on *in vitro* investigations carried out in human and animal cell lines. The protective effects of polyphenols are due to their antioxidant properties as oxidative stress is the major cause of various chronic diseases (Pandey & Rizvi 2009; Scalbert *et al*., 2005a; Santhosh *et al*., 2022). Further moisture content in food grains during harvest and storage promotes pathogenic infection. In this regard, in the present investigation, different varieties of maize grains were procured locally and evaluated for their moisture content, polyphenol profile, antioxidant potential, and their aflatoxin production in selected maize varieties.

MATERIALS AND METHODS

Chemicals and reagents. 2, 2-diphenyl-1-picrylhydrazyl (DPPH), Gallic acid, Caffeic acid, Tannic acid, trans-Ferulic acid, and Catechol were procured from Sigma-Aldrich, Germany. Cinnamic acid Sigma-Aldrich, China, Folin Ciocaulteu's reagent (Fischer Scientific, India), Vanillin (Hi Media, India), Sodium Carbonate (Qualigens, India). Acetonitrile, Phosphoric acid, and Methanol were of HPLC grade. All other chemicals and reagents were of analytical grade.

Collection of biological samples. In this study, ten maize grain varieties were used, which were procured from local markets of different parts of Telangana state, India. To avoid commercial bias and maintain transparency, all the samples were assigned code numbers *Zea mays (*MZ-1 to MZ-10) and studied for basic moisture and polyphenol content. The polyphenol extracts of the maize were then subjected to HPLC analysis for their characterization and later analyzed for their anti-oxidant potential and aflatoxin production in selected maize varieties.

Moisture content. The moisture content of the maize varieties was determined by using (Citizen MB40 moisture analyzer balance, Pune.) provided with a halogen heating lamp. Sub-samples from the different maize grain varieties were taken (2g equivalent) in triplicates. The moisture meter was kept on and then the sample grains were placed on the heating pan temperature range of 45 - 110˚C till the instrument displayed the %M and the values were recorded.

Extraction of polyphenols. Extraction of the polyphenols from the maize varieties was achieved according to the procedure reported by Nigel Whittle (1999). Maize grains (5g) were powdered by grinding in a mechanical grinder (Sumeet). This powder was stirred with 5mL of (acetone /water, 70:30) for 1h. This was followed by a passing slow stream of nitrogen bubbling through the suspension for 1min for removal of residual oxygen. The solution was filtered through filter paper loaded with solid sodium chloride (1-2g). After the layers were separated the upper acetone layer was retained and the lower aqueous layer was discarded. The acetone layer was evaporated to dryness using a concentrator plus (Eppendorf; India) set at 45°C. The residue was re-dissolved in 1 mL of acetonitrile/water (30/70) containing 0.1% acetic acid and passed through a (0.4µm) membrane filter for HPLC analysis.

Estimation of total phenol content: Total phenolic content was determined by using the phenol reagent (Folin Ciocalteu's) method reported by (Singleton *et al*., 1999) using catechol as the reference standard, and the absorbance was recorded at 640nm using (Cary60 UV-Vis Spectrophotometer, Agilent technologies USA). Different concentrations of catechol (1.25 to 7.5µg 400µL^{-1} of methanol) were taken in clean and fresh Eppendorf tubes. To this, Folin Ciocalteu's reagent (2N; 75µL) followed by Na_2CO_3 (20%; 400µL) were added. The mixture was vortexed and allowed to stand for 15min at room temperature. The mixture was then diluted with 1.25 mL of water, vortexed, and centrifuged for 15 min at 1500×g at room temperature. The supernatants were separated and the absorbance was measured at 640nm.A reagent blank was also prepared and used to calibrate the instrument. A calibration graph was generated based on the linear regression analysis between concentrations of catechol and absorbance (640nm) with R^2=0.9978. The concentration of polyphenols was computed using the calibration curve and the TPC was calculated and expressed per gram of the maize varieties.

Characterization of polyphenols by HPLC analysis. The polyphenol extracts were further filtered through

0.45µm PVDF hydrophilic membrane filters and analysis was performed by high-pressure liquid chromatography (HPLC). The separation and identification of polyphenol compounds were carried out as per the procedure described by Antoanela Popescu (2011). The HPLC system (Agilent Technologies 1260 Germany) is provided with a quaternary pump, DAD detector, thermostat, degassing system, autosampler, chromatographic column C18, 250mm × 4.6mm; 5 µm (Zorbax XDB or equivalent) was used. The mobile phase used was a gradient with a combination of A solution (phosphoric acid 0.1%) and B solution (acetonitrile) (Table 1). The analysis was carried out at a temperature set to 35^0C, flow rate of 1.5mL min^{-1}, detection: UV310nm, injection volume: 20µL, and analysis time: 30min.

Preparation of reference standards (solutions in methanol 70%). Five different reference standard polyphenols were prepared in methanol (70%) as specified: caffeic acid (0.36 $mgmL^{-1}$), cinnamic acid (0.58$mgmL^{-1}$), vanillin (0.42$mgmL^{-1}$), gallic acid (0.39mg mL^{-1}) and trans ferulic acid (0.100$mgmL^{-1}$).

Evaluation of antioxidant potentials of the maize polyphenol extracts:

The free radical scavenging activity of maize extracts was measured as a function of hydrogen donating or radical scavenging ability using the stable radical DPPH based on the method reported by Gul *et al*. (2013), with modification adopted to 96 well plates. The DPPH radical solution was prepared in methanol (0.004% w/v) and then 225 µL of this solution was mixed with 25 µL of maize extract containing polyphenol (10-100 μgmL^{-1}). The solutions were then incubated at room temperature in the dark for 30 min at the end of which the absorbance was measured at 517nm. Methanol (95%), DPPH solution, and ascorbic acid (0.4$mgmL^{-1}$) were used as blank, control, and reference respectively. The % radical scavenging activity is calculated according to the formula.

% Radical scavenging activity = ($Abs_{control}$ - Abs_{sample} /$Abs_{control}$) *100

Production of aflatoxin B_1 in selected maize varieties. The toxigenic fungal strain *Aspergillus flavus* (NRRL 6513) was obtained from the United State Department of Agriculture (USDA), ARS culture collection, Peoria, Illinois, USA. Cultures were maintained on potatodextrose agar (PDA) slants for eight days at 28.0 ±1˚Cina BOD incubator (Kalorstat, Dwaraka Equipment (P) Ltd., Mumbai, India).

Inoculation of maize grains with *Aspergillus flavus* (NRRL 6513). In order to find an optimum moisture content of the maize varieties for aflatoxin elaboration, the maize grains (50 g) were dried to a constant weight earlier and were washed 2-3 times with sterilized glass distilled water and surface sterilized with sodium hypochlorite solution (1% v/v) and washed thoroughly with distilled water 2-3 times to remove any residual sodium hypochlorite solution. The maize grains were separately pre-soaked in sterilized glass distilled water in a clean Erlenmeyer flask (250 mL) to retain a moisture content of 18%. The maize grains (5 g) were transferred into a clean Erlenmeyer flask (250mL) pre-sterilized in a laboratory autoclave at 1.05 kg cm^{-2}(103 kPa) pressure at 121°C for 15minutes.

Fungal spore inoculum in a volume of 500 µL containing 1×10^6 spores prepared in 0.01% Tween-20 was added to 5.0g of grain samples, in the laminar flow hood under aseptic conditions. These samples were incubated at 28 ± 1˚C and the fungi were allowed to grow for a period of 9 days. The samples were maintained in duplicate flasks and two sub-samples were drawn from each of the duplicate flasks for analysis. The samples were dried in a vacuum oven at 20 kg cm^{-2} and at 40-45˚C for 48 hours. After drying, samples were powdered in a mechanical grinder to a particle size of 0.4 mm. The grain samples were analyzed for the presence of aflatoxins. The flasks containing maize grains without inoculation were also incubated which served as controls before the inoculation of fungal spores, in order to avoid any background interference (Kosuri Tanuja 2012).

Extraction and estimation of aflatoxins from maize varieties

The dried maize grains were ground in a high-speed mechanical blender (Sumeet, Mumbai, India) to a fine powder. The powdered maize samples were defatted using a Soxhlet apparatus (Borosil, Mumbai, India) using *n*-hexane as a solvent. The defatted maize powder (1.0g) was extracted with 5.0mL of methanol: water (55:45)using a mechanical shaker for one hour. Later the samples were centrifuged, the aqueous methanolic phase was transferred into a separating funnel and an equal volume of chloroform was added and mixed thoroughly. The chloroform layer containing the toxin was separated and dried using a flash evaporator (Equitron roteva). The dried samples were stored at -20˚C until further analysis by TLC.

The residues were re-dissolved in a known volume of (0.25mL) of benzene: acetonitrile (98:2). The TLC plates were developed in toluene: ethyl acetate: formic acid (6:3:1) solvent system and visualized under long wave ultraviolet light (365 nm). Aflatoxins were separated and estimated by the thin layer chromatography /fluorescent digital image-based gel documentation system (Molecular Imager Gel Doc XR+ Imaging System, Bio-Rad). Coupled with software for analyzing digital image intensity values of the spots which were measured as peak volume. Reference standard AFB_1 was used for calculating toxin content in the samples (Kosuri Tanuja G. K., 2012).

RESULTS AND DISCUSSION

The moisture content of the maize varieties. The moisture content (M%) of the maize grain kernel varieties was analyzed and determined using the moisture meter. The MZ-9 variety exhibited highest moisture content (3.02% M), followed by MZ-3(2.64%M), MZ-5(2.60%M), MZ-8(2.21%M), MZ-7(2.11%M), MZ-10(2.10%M), MZ-6(2.00% M),MZ-1(1.99%M), MZ-4(1.98%M) respectively and the MZ-2 variety had least moisture content (1.79% M) and are represented in Table 2.

The total polyphenol content of the maize varieties: Total phenolic content was determined by using the phenol reagent (Folin Ciocalteu's) method in the ten different maize varieties using catechol as the reference standard and a calibration graph was generated based on the linear regression analysis between concentrations of catechol and absorbance (640 nm) with R^2=0.9978. previous studies also showed catechol as a reference standard by Sinha *et al*. (2021) (Fig. 1). The total polyphenol content was found to be in the range of 33 - 190 µg g^{-1} (catechol equivalent). The MZ-7 variety had the highest total polyphenol content (190 ± 0.66 µg g^{-1}), followed by MZ-9 (128 ± 0.20 µg g^{-1}), MZ-3 (118 ± 0.21 µg g^{-1}), MZ-6 (76 ± 0.79 µg g^{-1}), MZ-1 (64 ± 0.28 µg g^{-1}), MZ-10 (58 ± 0.32 µg g^{-1}), MZ-4 (55 ± 0.91µg g^{-1}), MZ-5 (54 ± 0.10 µg g^{-1}), MZ-8 (44 ± 0.65µg g^{-1}) respectively and the MZ-2 variety had the lowest (33 ± 0.29µg g^{-1}) (Table 3). Abbreviations: MZ: *Zea mays*; values (X±SD)mean ± standard deviation

Characterization of polyphenols by HPLC analysis. The HPLC analysis of the maize extracts and the reference standard polyphenols was carried out and chromatograms obtained were recorded (Fig. 2). The peaks were identified by comparing the retention time of the maize extracts with those of the standard polyphenols (Table 4). The analysis revealed that cinnamic and trans-ferulic acids are the most commonly occurring polyphenols in all maize varieties. Other phenolics like vanillin, and gallic acid were also present and caffeic acid was observed to be the least in the different maize varieties studied (Fig. 3). Hence, total polyphenol content also differed with the maize varieties. The MZ-5 variety followed by MZ-7, M-Z6, and MZ-4 exhibited maximum polyphenol profile. The MZ-8, MZ-10, and MZ-9 varieties depicted a moderate polyphenol profile. The MZ-2 maize variety showed the least polyphenol profile followed by MZ-1 and MZ-3 respectively. The maize variety MZ-1 had cinnamic acid, trans ferulic, gallic, caffeic acids, and vanillin. The MZ-2 and MZ-3 varieties exhibited the presence of cinnamic, gallic, and trans ferulic acid while vanillin and caffeic acids were not detected. The MZ-4 depicted the presence of cinnamic, trans ferulic, gallic, vanillin, and caffeic acid. TheMZ-5 and MZ-6 varieties exhibited the presence of most of the polyphenols including cinnamic acid, trans ferulic acid, gallic acids, vanillin, and caffeic acids. The MZ-7 and MZ-8 varieties had cinnamic, trans ferulic, gallic acid, and vanillin. The MZ-9 variety showed the presence of trans ferulic, gallic, and cinnamic acids. The MZ-10 variety depicted the presence of caffeic, cinnamic, trans ferulic, gallic acid, and vanillin (Table 4).

Screening the antioxidant potentials of extracts of the maize varieties. Six different reference standard polyphenols were prepared in methanol (70%) as specified: caffeic acid (0.36mg mL^{-1}), cinnamic acid (0.58mg mL^{-1}), vanillin (0.42mgmL^{-1}), gallic acid (0.39mgmL^{-1}), trans ferulic acid (0.100mgmL^{-1}) and ascorbic acid (0.40mgmL^{-1}) done for antioxidant potentials (Fig. 4). Antioxidant activity of the maize varieties was also done by DPPH assay and found that the MZ-5 variety had highest antioxidant potential (79.18%) followed by MZ-10 (77.20%), MZ-1 (76.31%), MZ-8 (74.12%), MZ-9 (72.84%) MZ-3 (72.17%), MZ-7 (69.16%), MZ-6 (68.17%,) MZ-2 (67.60%) respectively and found lowest in the MZ-4 variety (62.89%) (Fig. 5). These results indicate that extracts of all the maize varieties showed good antioxidant potentials.

Maize grain kernels are one of the highly suitable substrates for infestation by pathogenic fungi such as *Aspergillus, Fusarium, and Penicillium*. The growth of these organisms and the elaboration of specific mycotoxins are largely influenced by the nutritional status and moisture content. In this regard, in the present study, moisture content from these maize grain kernels was estimated. The MZ-9 variety showed the highest (3.02) %M while the MZ-2 variety showed the lowest (1.79) %M. This data on initial moisture content in maize grain kernel extracts would give more scope to investigate their resistance to fungal diseases as a future scope for further investigation as moisture content greater than 14% in maize grains during storage has been reported to promote infestation by fungi and insects (Likhayo *et al*., 2018).

Polyphenols have been reported to be play a major role in the development of resistance in most agricultural food grains (Bernardi *et al*., 2018). Hence the polyphenol profile of the different maize varieties collected from the local areas was analyzed in the present study. The study revealed a varied presence and percentages of different polyphenols suggesting varied resistance among the varieties. Additionally, polyphenol extracts were also analyzed for their antioxidant potentials and all the extracts depicted the antioxidant potentials based on their DPPH scavenging assay. In the present era, nutritional-based therapeutic strategies are gaining more attention due to their safer and biocompatible properties. The major factors responsible for chronic diseases in humans include genetic, environmental, and nutritional deficiencies. However, most of these factors lead to oxidative stress at the cellular level increasing the intensity of the diseases (Scalbert *et al*., 2005b). In this regard, supplementation of foods rich in antioxidants proves to be beneficial. Maize is a major staple food consumed worldwide ranking next to rice and wheat, the aim of the present study was to screen the polyphenol profile and estimate their antioxidant potentials. The MZ-7 variety had the highest total polyphenol content (190µg g^{-1}), medium by the MZ-3 (128µg g^{-1}) whereas the MZ-2 had the lowest (33µg g^{-1}). The HPLC analysis of the maize varieties was done and found that most of the phenolics were present while cinnamic and trans ferulic acid were abundant among the others. Among all the maize varieties the MZ-5 variety was found to be abundant in most of the phenolics especially highest in gallic acid followed by trans ferulic, and cinnamic acids. It also had good amounts of vanillin and caffeic acids, along with these there are other phenolics with cinnamic acid followed by trans ferulic and gallic acids, low in vanillin and caffeic acid. Antioxidant activity of the maize varieties was also done by DPPH assay and found that the MZ-5 variety had the highest antioxidant potential (79.18%) correlating with the high polyphenol content in this variety compared to others.

Production of aflatoxin B_1 on selected varieties of maize. The maize varieties were selected based on the polyphenol content observed, the MZ-2 variety having low, the MZ-3 variety having medium, and the MZ-7 variety having high polyphenol content taken for infestation by *Aspergillus flavus* (NRRL 6513) and aflatoxin elaboration depicted in (Fig. 6) along with control flask.

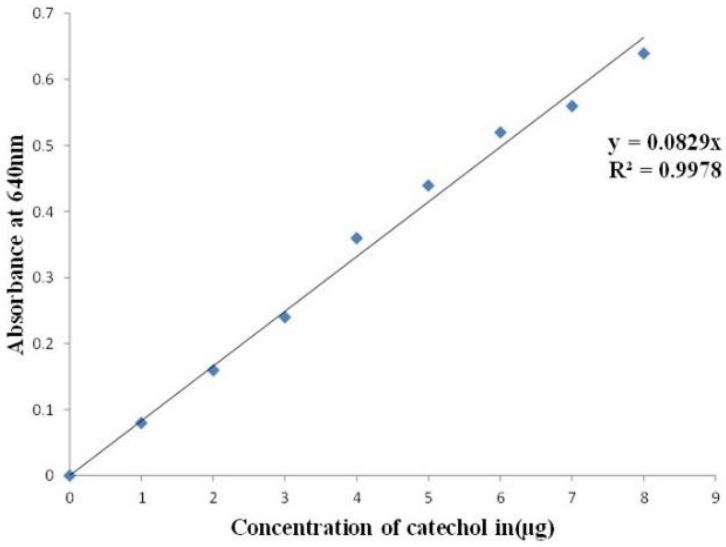

Fig. 1.

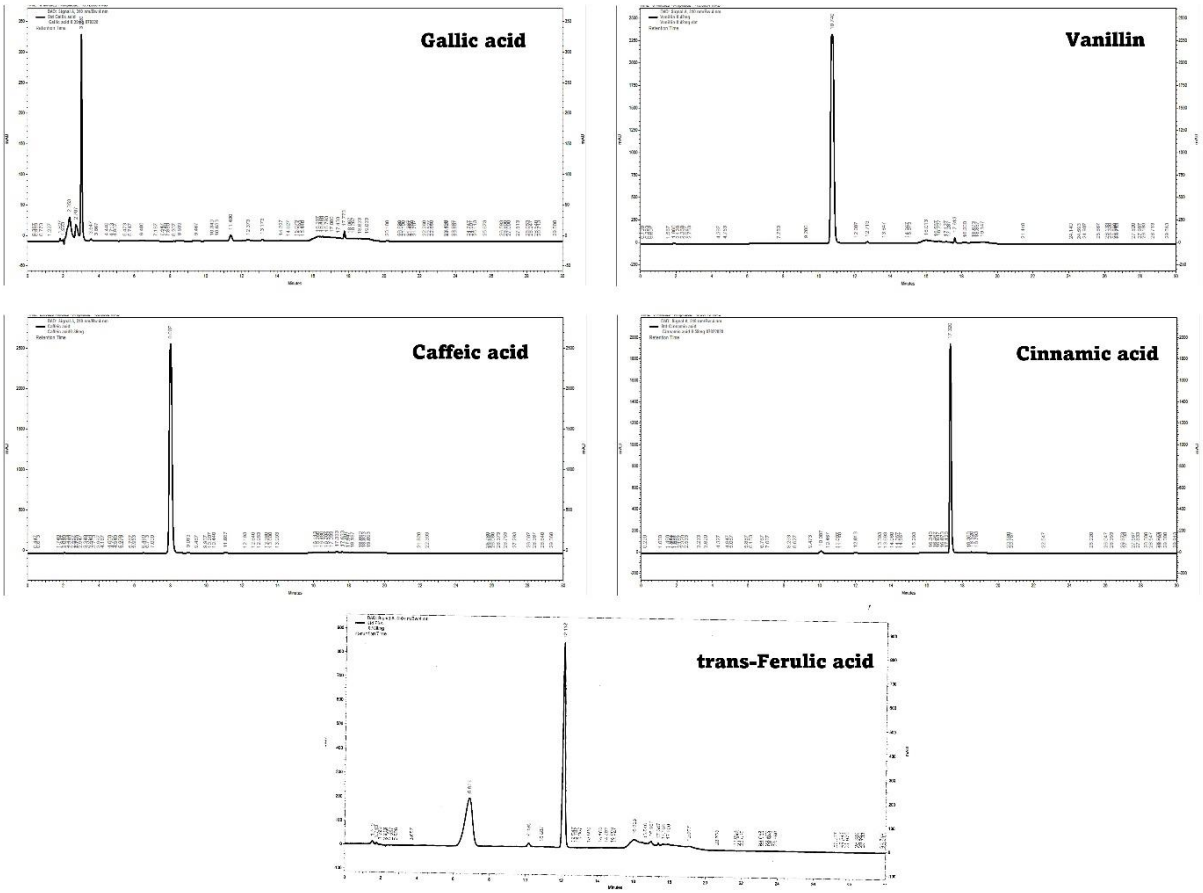

Fig. 2.

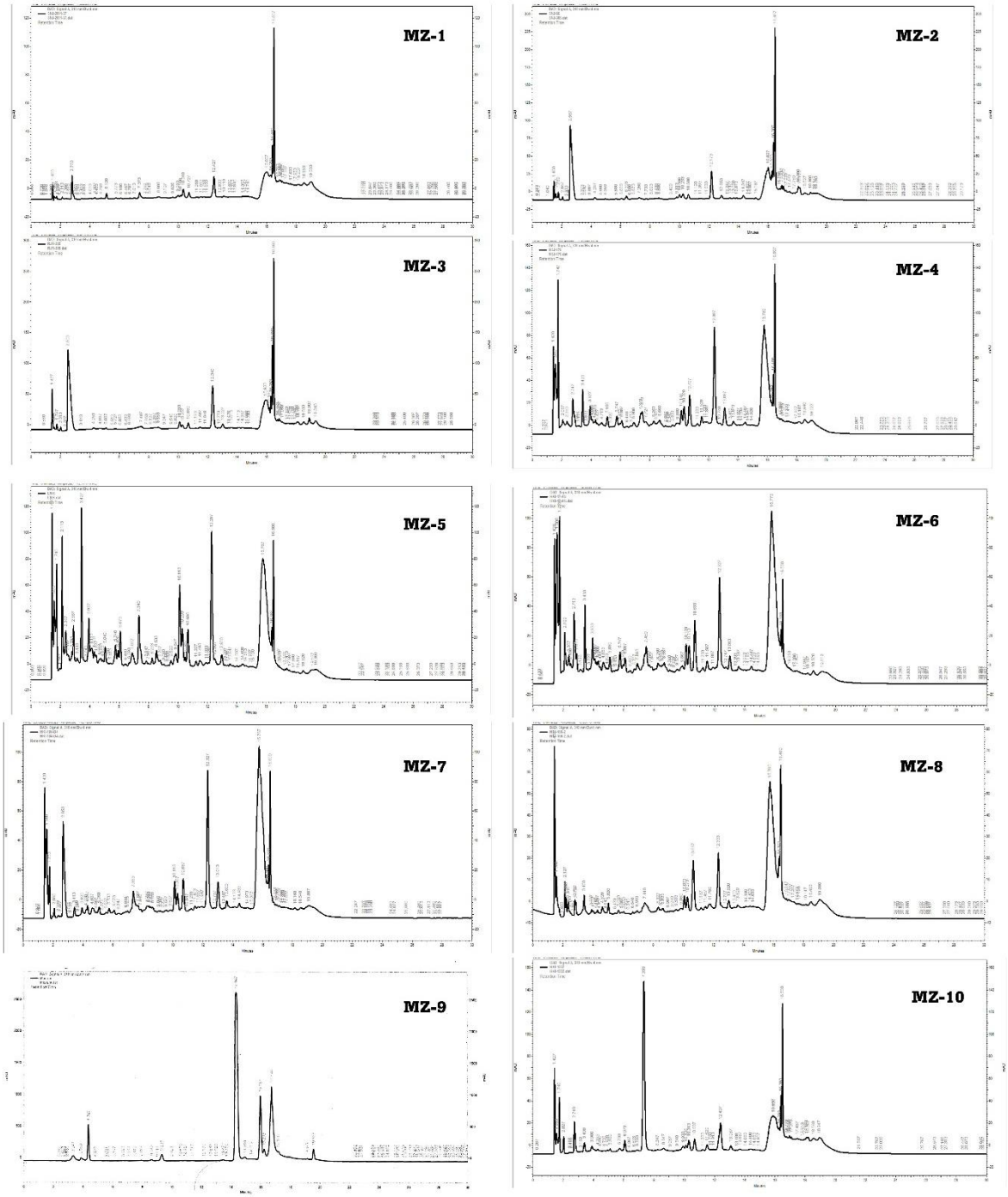
MZ-1
MZ-2
MZ-3
MZ-4
MZ-5
MZ-6
MZ-7
MZ-8
MZ-9
MZ-10

Fig. 3.

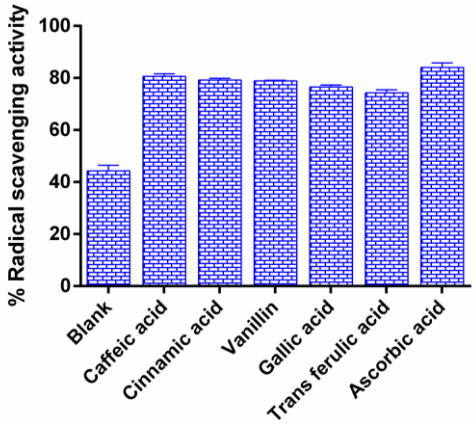
% Radical scavenging activity
100
80
60
40
20
0
Blank
Caffeic acid
Cinnamic acid
Vanillin
Gallic acid
Trans ferulic acid
Ascorbic acid

Fig. 4.

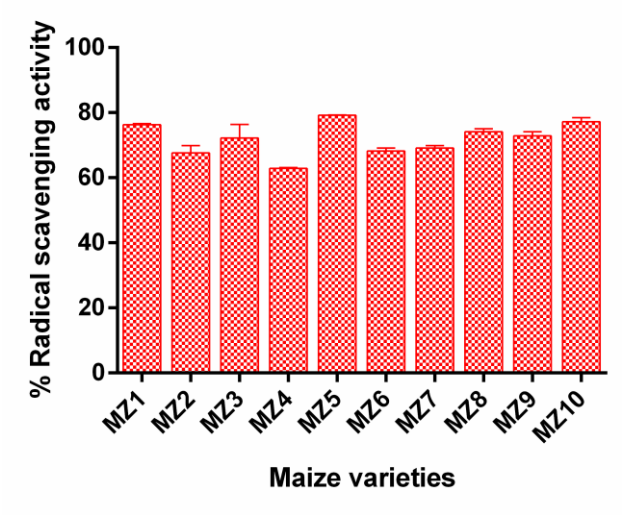

Fig. 5.

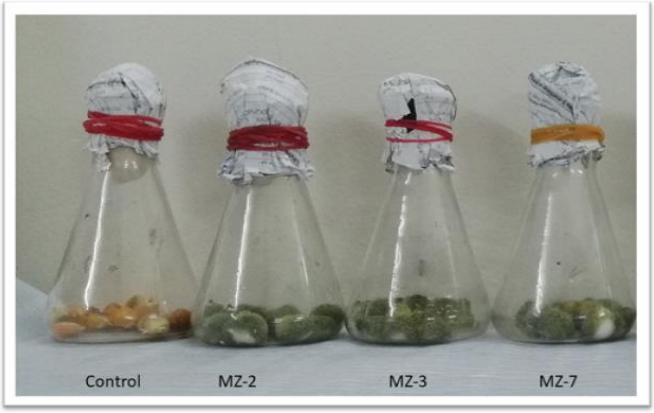

Fig. 6.

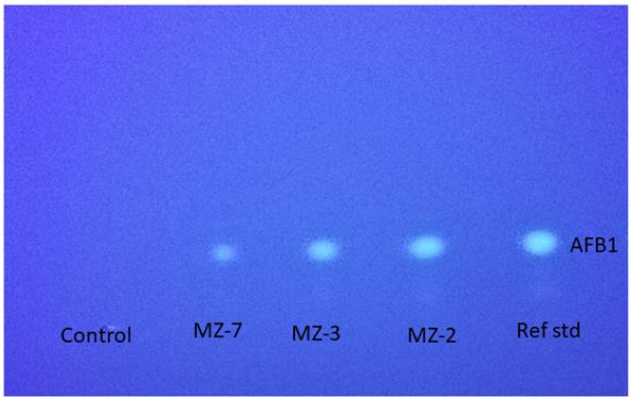

Fig. 7.

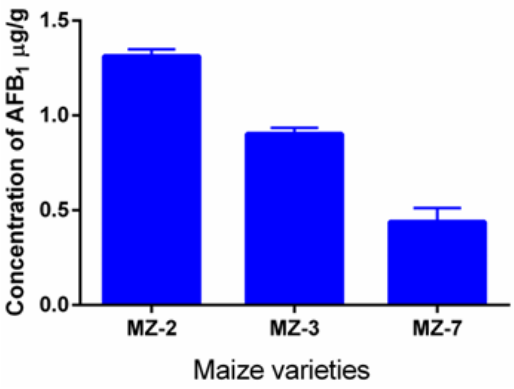

Fig. 8.

Table 1: Preparation of the gradient of the mobile phase.

Time (min)	Solution A (mL%)	Solution B (mL%)
0-13	90	10
13	78	22
13	78	22
14	60	40
17	60	40
17.5	90	10
22	90	10

Table 2: Moisture content in different maize varieties.

Sr. No.	Name of the maize variety	%Moisture g^{-1}
1.	MZ-1	1.99
2.	MZ-2	1.79
3.	MZ-3	2.64
4.	MZ-4	1.98
5.	MZ-5	2.60
6.	MZ-6	2.00
7.	MZ-7	2.11
8.	MZ-8	2.21
9.	MZ-9	3.02
10.	MZ-10	2.10

Table 3: Total Polyphenol content of different maize varieties.

Sr. No.	Name of the variety (MZ)	Total Polyphenol content(µgg^{-1}) (X±SD)
1.	MZ-1	64 ±0.281
2.	MZ-2	33 ±0.298
3.	MZ-3	118 ±0.21
4.	MZ-4	55 ±0.915
5.	MZ-5	54 ±0.101
6.	MZ-6	76 ±0.792
7.	MZ-7	190 ±0.668
8.	MZ-8	44 ±0.654
9.	MZ-9	128 ±0.20
10.	MZ-0	58 ±0.328

Abbreviations: MZ, *Zea mays*; values **(X±SD)** mean ± standard deviation

Table 4: HPLC Retention time of reference standard polyphenol compounds.

Sr. No.	Polyphenol compound	*Retention time(min)
1.	Gallic acid	3.020±0.891
2.	Caffeic acid	8.240±0.329
3.	Vanillin	10.533±0.223
4.	trans Ferulic acid	12.113±0.166
5.	Cinnamic acid	16.824±0.987
6.	Tannic acid	17.760±0.693

*Mean ± SD of triplicate values

CONCLUSIONS

Ten different varieties of maize grains (kernels) were collected from the local region and analyzed for their inherent moisture content, polyphenol profile, antioxidant potentials, and aflatoxin production in selected maize varieties which exhibited an increase in the amount of polyphenol-resisted production of aflatoxin.

FUTURE SCOPE

The data obtained may give an insight into the understanding of the differential resistance among the maize grains to infestation by toxigenic fungi and pests.

Author contributions: Venkataiah Bhootham collected the biological samples, designed, and performed the experiments, Mir Zahoor Gulanalyzed the data,and Vidya Chernapallirepeated the analysis. All authors contributed to the writing, and Dr Karuna Rupula revised the manuscript. All authors have read and approved the final manuscript.

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Conflict of Interest. None.

REFERENCES

Aggarwal, S. (2017). Nutrient and Non-nutrient Antioxidant Evaluation of Maize (*Zea mays* L.). *Journal of Medical Science and Clinical Research*, *5*(06), 23873–23878.

Akshay, K. (2023). Combing Ability of Yield and quality Contributing Attributes in Fodder Maize (*Zea maize* L.). *Biological Forum-An International Journal*, *15*(8), 352.

Antoanela POPESCUa, T. N. – Pîrjol. C. Rosca. M. Arcus. L. Bucur. and V. Istudor. (2011). HPLC analysis of polyphenols and antioxidant capacity determination of *Scirpus holoschoenus* L. rhizome. *Ovidius University Annals of Chemistry*, *22*(1), 62–66.

Bankole, S., Schollenberger, M., & Drochner, W. (2006). Mycotoxins in food systems in Sub Saharan Africa: A review. *Mycotoxin Research*, *22*(3), 163–169.

Bernardi, J., Stagnati, L., Lucini, L., Rocchetti, G., Lanubile, A., Cortellini, C., De Poli, G., Busconi, M., &Marocco, A. (2018). Phenolic Profile and Susceptibility to Fusarium Infection of Pigmented Maize Cultivars. *Frontiers in Plant Science*, *9*.

Butts-Wilmsmeyer, C. J., Mumm, R. H., Rausch, K. D., Kandhola, G., Yana, N. A., Happ, M. M., Ostezan, A., Wasmund, M., & Bohn, M. O. (2018). Changes in Phenolic Acid Content in Maize during Food Product Processing. *Journal of Agricultural and Food Chemistry*, *66*(13), 3378–3385.

Dai, J., & Mumper, R. J. (2010). Plant Phenolics: Extraction, Analysis and Their Antioxidant and Anticancer Properties. *Molecules*, *15*(10), 7313–7352.

Ferrigo, D., Raiola, A., & Causin, R. (2016). Fusarium Toxins in Cereals: Occurrence, Legislation, Factors Promoting the Appearance and Their Management. *Molecules*, *21*(5), 627.

García-Lara, S., Bergvinson, D. J., Burt, A. J., Ramputh, A. I., Díaz-Pontones, D. M., & Arnason, J. T. (2004). The Role of Pericarp Cell Wall Components in Maize Weevil Resistance. *Crop Science*, *44*(5), 1546–1552.

Ghafory, H., Yousefinejad, V., Mohammadi, K., & Piri, M. (n.d.). *Effect of Phenolic Compounds as Antioxidant on Cell Oxidation: A Review*. www.researchtrend.net

Gul, M. Z., Ahmad, F., Kondapi, A. K., Qureshi, I. A., & Ghazi, I. A. (2013). Antioxidant and antiproliferative activities of Abrusprecatorius leaf extracts - an in vitro study. *BMC Complementary and Alternative Medicine*, *13*(1), 53.

Horvat, D., Šimić, G., Drezner, G., Lalić, A., Ledenčan, T., Tucak, M., Plavšić, H., Andrić, L., & Zdunić, Z. (2020). Phenolic Acid Profiles and Antioxidant

Activity of Major Cereal Crops. *Antioxidants*, *9*(6), 527.

Likhayo, P., Bruce, A. Y., Tefera, T., & Mueke, J. (2018). Maize Grain Stored in Hermetic Bags: Effect of Moisture and Pest Infestation on Grain Quality. *Journal of Food Quality*, *2018*, 1–9.

Liu, R. H. (2004). Potential Synergy of Phytochemicals in Cancer Prevention: Mechanism of Action. *The Journal of Nutrition*, *134*(12), 3479S-3485S.

Manach, C., Williamson, G., Morand, C., Scalbert, A., & Rémésy, C. (2005). Bioavailability and bioefficacy of Muramatti, G., Sarangi, K. K., Mishra, S. N., & Dash, A. (2022). Production and marketing Constraints of maize in Karnataka state. *Biological Forum-An International Journal*, *14*(4), 1321. www.researchtrend.net

NigelWhittle, H. andJohnBartley. (1999). IdentificatIdentification of the Polyphenols in Barley and Beer by HPLC/MS and HPLC/Electrochemical Detection. *Journal of The Institute of Brewing*, *105*(2), 89–99.

Nuss, E. T., &Tanumihardjo, S. A. (2010). Maize: A Paramount Staple Crop in the Context of Global Nutrition. *Comprehensive Reviews in Food Science and Food Safety*, *9*(4), 417–436.

Priyanka, T., & Sujata, M. (2023). Estimation of Total Phenolic and Flavonoid Content and Antioxidant Activity in Catharanthus roseus L. (Alba) Plant Extract. *Biological Forum-An International Journal*, *15*(2), 1101.

Pandey, K. B., & Rizvi, S. I. (2009). Plant Polyphenols as Dietary Antioxidants in Human Health and Disease. *Oxidative Medicine and Cellular Longevity*, *2*(5), 270–278.

Parle, M., & Dhamija, I. (2013). Zea Maize: A Modern Craze. *International Research Journal of Pharmacy*, *4*(6), 39–43.

Probst, C., Bandyopadhyay, R., & Cotty, P. J. (2014). Diversity of aflatoxin-producing fungi and their impact on food safety in sub-Saharan Africa. *International Journal of Food Microbiology*, *174*, 113–122.

Ramos-Escudero, F., Muñoz, A. M., Alvarado-Ortíz, C., Alvarado, Á., &Yáñez, J. A. (2012). Purple Corn (*Zea mays* L.) Phenolic Compounds Profile and Its Assessment as an Agent Against Oxidative Stress in Isolated Mouse Organs. *Journal of Medicinal Food*, *15*(2), 206–215.

Rouf Shah, T., Prasad, K., & Kumar, P. (2016a). Maize A potential source of human nutrition and health: A review. *Cogent Food & Agriculture*, *2*(1).

Rouf Shah, T., Prasad, K., & Kumar, P. (2016b). Maize A potential source of human nutrition and health: A review. *Cogent Food & Agriculture*, *2*(1).

Sinha, S., Singh, S. P., & Swami, M. N. (2021). Kinetic and Mechanistic Profile of Some Phenolic Compounds by N-Chlorosaccharin in Aqueous Acid Medium. *International Journal of Theoretical & Applied Sciences*, *13*(2), 36. www.researchtrend.net

Sai Pratyusha, V., Lakshmi, Y. S., Pragna, G., Apoorva, B., Rushyamee, S., & Salman Pasha, M. (2022). Performance Evaluation of Aquacrop Model for Sweet Corn for Northern Telangana Zone. *Biological Forum-An International Journal*, *14*(4a), 624. www.researchtrend.net

Santhosh, G., Umamaheshwari, R., Shivashankara, K. S., Ponnam, N., Reddy, D. C. L., Anjali, T., Nayak, D. K., & Dash, B. K. (2022). Unraveling the Role of Phenolic and Flavonoid Compounds in Chilli Resistance to Root Knot Nematodes. *Biological Forum-An International Journal*, *14*(4), 1315. www.researchtrend.net

Scalbert, A., Manach, C., Morand, C., Rémésy, C., & Jiménez, L. (2005a). Dietary Polyphenols and the Prevention of Diseases. *Critical Reviews in Food Science and Nutrition*, *45*(4), 287–306.

Scalbert, A., Manach, C., Morand, C., Rémésy, C., & Jiménez, L. (2005b). Dietary Polyphenols and the Prevention of Diseases. *Critical Reviews in Food Science and Nutrition*, *45*(4), 287–306.

Singh, I., Krishna, R., Ahmad, K., & Kumar, A. (2023). Phytochemical Characterization, Antioxidant and Antibacterial Activity Evaluation of Ethanolic extract of Piper longum Root. *Biological Forum-An International Journal*, *15*(2), 94.

Singleton, V. L., Orthofer, R., & Lamuela-Raventós, R. M. (1999). *Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent* (pp. 152–178).

Siyuan, S., Tong, L., & Liu, R. (2018). Corn phytochemicals and their health benefits. *Food Science and Human Wellness*, *7*(3).

Slavin, J. L., & Lloyd, B. (2012). Health Benefits of Fruits and Vegetables. *Advances in Nutrition*, *3*(4), 506–516. Wootton-Beard, P. C., Moran, A., & Ryan, L. (2011). Stability of the total antioxidant capacity and total polyphenol content of 23 commercially available vegetable juices before and after in vitro digestion measured by FRAP, DPPH, ABTS and Folin–Ciocalteu methods. *Food Research International*, *44*(1), 217–224.

Zhang, R., Huang, L., Deng, Y., Chi, J., Zhang, Y., Wei, Z., & Zhang, M. (2017). Phenolic content and antioxidant activity of eight representative sweet corn varieties grown in South China. *International Journal of Food Properties*, *20*(12), 3043–3055.

Zhang, Y.-J., Gan, R. Y., Li, S., Zhou, Y., Li, A. N., Xu, D. P., & Li, H. B. (2015). Antioxidant Phytochemicals for the Prevention and Treatment of Chronic Diseases. *Molecules*, *20*(12), 21138–21156.

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