



The effect of fungi spoilage on the nutritional value of corn in langtang north local government area of plateau state

Joel S Sangari, Queen C Maduagwu, Cyril W Yilyok, Lawrence W Biska, Dandam Nanbyen

Department of Biology, Federal College of Education, Pankshin, Plateau State, Nigeria

Abstract

This study Determined the Effect of Fungi Spoilage on the Nutritional Value of Corn in Langtang North Local Government Area of Plateau State. Maize also known as Corn were purchased from three different market (Sample A: Langtang North main market. Sample B: Shishiri market, Langtang North. Sample C: Kwanpe main market) located in Langtang North Local Government Area of Plateau State, and aseptically stored in labeled transparent white polythene bags. The purchased samples of Maize were transported to the Microbiology Laboratory of the National Veterinary Research Institute (NVRI) VOM, Jos Plateau State for Immediate Processing and Analysis. The results of the frequency of visible colonies shows the micro-organism isolated from the three (3) maize corn samples together with their frequency of occurrence. The Trichophyton spp was found once in samples A and none in sample B and C. Aspergillus spp also was found once in sample C and none in sample A and B. Rhizopus spp was found in sample B and C but not in sample A while Penicillium spp was found in sample B and C but not in sample A. The results of the spore formation, motility and biochemical identification of isolates shows that the Trichophyton spp was positive in carbohydrate assimilation, spore formation but negative in Amino Acid Assimilation, motility, hydrolysis and lipase activity. Aspergillus spp was positive in carbohydrate assimilation, spore formation and Amino Acid Assimilation but negative in motility, hydrolysis and lipase activity. Rhizopus spp was positive in carbohydrate assimilation, Amino Acid Assimilation and lipase activity but negative in spore formation, motility, hydrolysis. Penicillium spp was positive in carbohydrate assimilation, Amino Acid Assimilation and lipase activity but negative in spore formation, motility, hydrolysis. In conclusion, maize can be infected by fungi irrespective of storage condition. Therefore, the researcher recommended that proper and effective storage of maize through different techniques should be put in place, public awareness should be increased to sensitized people about the harmful effect of fungi on Maize so as not post harm to them.

Keywords: maize, nutritional value, fungi, spoilage

Introduction

Cereal grains are grasses which members of the monocot families poaceae or gramineae, composed of the endosperm, germ and bran. Cereals constitute the major sources of energy, protein, vitamins and minerals for the world population (Fawole *et al.*, 2018) ^[9]. According to Gautam *et al.*, (2019), cereals grains of economic importance include; Maize, Millet, Sorghum, Maize, Wheat, Barley, Oats, and Rice (Adebayo *et al.*, 2018) ^[11].

Maize (*Zea mays*) also known as corn belong to the family Poaceae. It is the third most important cereal crop in the world (Adebayo *et al.*, 2018) ^[11] and one of the most staple foods in the Northern Nigeria. Nigeria is one of the largest maize producing countries in Africa (Adebayo *et al.*, 2018) ^[11]. Maize grains have a high nutritional value and a complex chemical composition. These values may vary depending on the biological material studied. Maize flour is nutritious, tasty, easy to digest, regularly consumed, helps cleanse the colon, helps digestion by reducing stomach acid, consumed as popcorn helps avoid constipation and consumed alongside the rest of the grains helps to reduce the development of certain cancers (Akinyemi *et al.*, 2019) ^[3]. It also contains booster of antioxidants that protect from various degenerative diseases. Maize is also used in supplementary nutrition programmes and integrated child development services programmes to feed malnourished children and to improve their health status (Akinyemi *et al.*, 2019) ^[3].

Nutritional quality of maize also depends on the processing method used. *Zea Mays* is a major cereal crop for both livestock feeds and human nutrition. Maize provides more carbohydrate than wheat and sorghum. The quality of maize protein is primarily a function of its essential amino acid composition. Common maize grains are low in protein, as its protein is deficient in two amino acids (lysine and tryptophan) which are essential for human (Akinyemi *et al.*, 2019) ^[3]. It is a good source of phosphorus, and contains small amount of calcium, iron, thiamine and niacin.

Maize grain is not consumed soon after harvest but often stored for many months to be sold or consumed later. It has been reported by several researchers that fungal infestation in maize results in color change, decreases in nutritional values, and reduction of overall quality and quantity of the maize. Fungi are agents of food

contamination and many species are saprobes, found in a variety of habitats and are ubiquitous agents of decay. Several of these fungal species have been found associated with production of mycotoxins, which are of public health importance (Ehrlich, 2017) [8]. Major fungi associated with grain storage, including maize, are *Aspergillus flavus*, *Fusarium* sp, and others. Fungal load in maize presents a major risk for humans and animals, through production of mycotoxins (especially Aflatoxins). While in storage, grains are mostly susceptible to infection by species of fungi. Infected grains by fungi result in reduced germination, visible mould discoloration; chemical and nutritional changes, increased its mustiness, production of carcinogenic toxins and finally leading to spoilage of grains in many ways (Dubale *et al.*, 2018).

Fungal growth in maize is facilitated by hot and humid conditions (Egal *et al.*, 2018) [7]. In tropical and subtropical countries, a large proportion of the grain (such as maize) is harvested and stored under hot and humid conditions, and most farmers lack proper knowledge, equipment and methods of drying grains (Weinberg *et al.*, 2018) [16]. To maintain high quality maize during storage, maize should be protected from weather (including relative humidity and temperature), growth of microorganisms, and insects (Adejumo and Adejoro, 2016) [2]. Also, poor harvesting practices, unsuitable storage conditions, improper transportation, marketing, and processing also contribute to fungal growth.

Materials and Methods

Study Area

The study area is in Langtang North. Langtang North is a Local Government Area in Plateau State, Nigeria. Its headquarters are in the town of Langtang. The geographical co-ordinates of Langtang are Latitude 9°08'00"N E and longitude 9°47'00"E. It has an area of 1,188 km² and a population of 140,643 at the 2006 census. The postal code of the area is 941. It has a population of 140, 643 as of 2006 population census. Language spoken in Langtang North is Taroh.

Cereals Collection

Spoiled Maize also known as Corn was purchased from three different market located Langtang North Local Government Area of Plateau State, and aseptically stored in labeled transparent white polythene bags according to method of (Okeme *et al.*, 2017) modified. They are as follow:

Sample A: Langtang North main market

Sample B: Shishiri market, Langtang North

Sample C: Kwanpe main market, Langtang North

The purchased cereals were transported to the microbiology laboratory of the National Veterinary Research Institute (NVRI) VOM, Jos Plateau State for immediate processing and analysis.

Sterilization of Glass Wares

Properly washed petri-dishes, test tubes, conical flasks, beakers, pipettes, knives, spatulas, etc., were sterilized in hot air oven at 180°C for two hours (2 h) and stored at 40°C.

Preparation of Culture Media (Sample)

The media for culturing were aseptically prepared when needed according to the manufacturer's instruction and autoclaved at 121°C for 15 min.

Preparation of Sample

Five folds serial dilutions of the sample were prepared.

Plating Technique

The diluted sample was used to inoculate the prepared media using pour plate method. The agar plates were allowed to solidify and placed in an inverted position for 7 days at 25°C, thereafter, their colonies were observed.

Identification and Characterization of Isolates

Spore Staining

The staining procedure for identification of spore was carried out by placing heat-fixed slide (containing the smear of the isolate) over a steaming water bath and placing of blotting papers over the area of the smear without sticking out past the edges of the slide. The blotting paper was then saturated with 5.6% solution of malachite green and steamed for 5 min. Following this, the slide was cooled to room temperature and then rinsed thoroughly with tap water. Safari was then applied for one minute and rinsed briefly but thoroughly before blotting dry. After which the slide was examined microscopically.

Motility Test

Fungal motility was determined by transferring a small drop of live isolates to the centre of a slip of a depression slide using petroleum jelly or 2-3 drops of peptone water with growth of the organism replaced on a clean slide with wire loop. Then cover slip was placed over the slide, the slide was left for some time and then examined microscopically with the high-power objective. Motile organisms were seen swimming around.

Carbohydrate Assimilation Test

Filtered and sterilized carbohydrates were added to the medium at concentration of 1% while the pH was adjusted to 5.4 by addition of NaOH or HCl. 2 ml of the media were dispensed into 10 ml test tube. The tubes were also inoculated with isolates and carbohydrates. All tubes were incubated at 20°C for 14 days. A change in the color of the medium of orange and yellow were taken as positive result. A change to pink or purple was considered negative result.

Amino-acid Assimilation Test

Medium preparation and indication were as described for the carbohydrate assimilation test. 10 mm test tubes containing 2 ml of the media were inoculated with the isolate and control tubes for each fungus and amino acid. Also, tubes were incubated at 20°C for 14 days. A change to pink or purple was considered positive result while a change in color of the medium to orange was taken as negative result.

Hydrolysis Test

The basal medium was similar to that of amino acid assimilation test with addition of 0.05 mg milk and 1.2 mg agar. After autoclaving at 110°C for 30 min, the medium was poured into petri dish. Isolates were inoculated at the centre of the plate and incubated at 20°C for 14 days. The appearance of a clear zone around the fungal colony was taken as a positive result.

Lipase Activity Test

The medium of 0.5% peptin, 0.3% yeast extract and 1.0% agar were autoclaved at 121°C for 10 min. It was filtered and dispensed into sterilized test tubes. Isolates were inoculated into the surface of the medium and incubated at 20°C for 7 days. The occurrence of clearance in the medium column was taken as a positive result.

Fungal Identification

The isolates were identified using cultural characteristics and morphology with reference to De Hoog *et al.* (2000) and Jay (1992).

Results

Frequency of Visible Colonies

The results depicted in table 1, showed the micro-organism isolated from the three (3) maize corn samples together with their frequency of occurrence. The *Trichophyton* spp was found once in samples A and none in sample B and C. *Aspergillus* spp also was found once in sample C and none in sample A and B. *Rhizopus* spp was found in sample B and C but not in sample A while *Penicillium* spp was found in sample B and C but not in sample A.

Table 1: Frequency of Visible Colonies

Isolates	Frequency/Number of Occurrence in both samples	Frequency (%)
<i>Trichophyton</i> spp.	1	14.29
<i>Aspergillus</i> spp.	1	14.29
<i>Rhizopus</i> spp.	2	28.57
<i>Penicillium</i> spp.	3	42.85

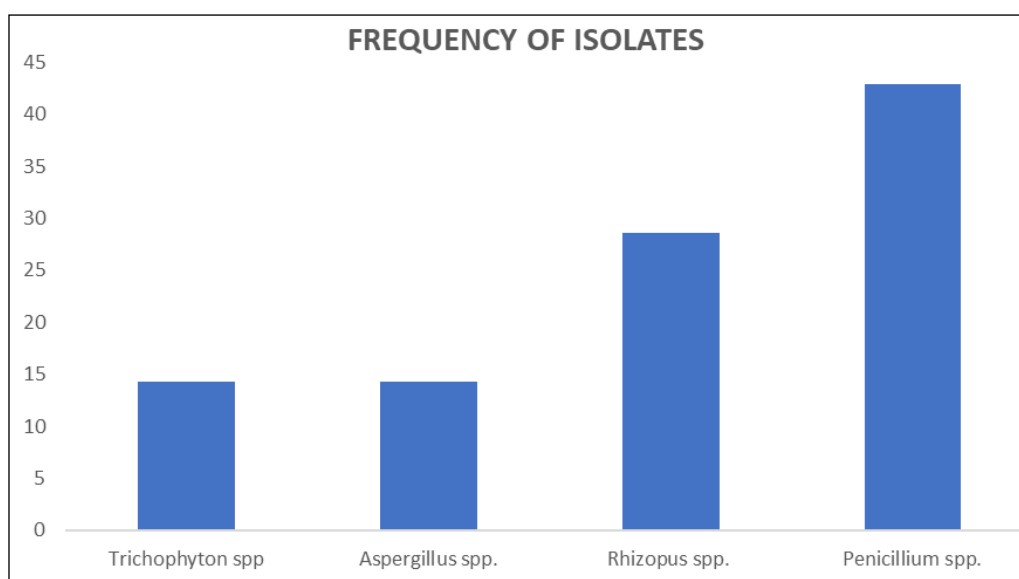


Fig 1: Frequency of Visible Colonies

Spore Formation, Motility and Biochemical Identification of Isolates

The table 2 show the spore formation, motility and biochemical identification of isolates. The *Trichophyton* spp was positive in carbohydrate assimilation, spore formation but negative in Amino Acid Assimilation, motility, hydrolysis and lipase activity. *Aspergillus* spp was positive in carbohydrate assimilation, spore formation and Amino Acid Assimilation but negative in motility, hydrolysis and lipase activity. *Rhizopus* spp was positive in carbohydrate assimilation, Amino Acid Assimilation and lipase activity but negative in spore formation, motility, hydrolysis. *Penicillium* spp was positive in carbohydrate assimilation, Amino Acid Assimilation and lipase activity but negative in spore formation, motility, hydrolysis.

Table 2: Spore Formation, Motility and Biochemical Identification of Isolates

No of isolates	Carbohydrate Assimilation	Spore Formation	Amino Acid Assimilation	Motility	Hydrolysis	Lipase Activity
<i>Trichophyton</i> spp.	+	+	-	-	-	-
<i>Aspergillus</i> spp.	+	+	+	-	-	-
<i>Rhizopus</i> spp.	+	-	+	-	-	+
<i>Penicillium</i> spp.	+	-	+	-	-	+

Discussions

Frequency of Visible Colonies

The results depicted in table 4.1, showed the micro-organism isolated from the three (3) maize corn samples together with their frequency of occurrence. The *Trichophyton* spp was found once in samples A and none in sample B and C. *Aspergillus* spp also was found once in sample C and none in sample A and B. *Rhizopus* spp was found in sample B and C but not in sample A while *Penicillium* spp was found in sample B and C but not in sample A. from the results, the total plate count of the visible colonies reveals that *Penicillium* spp were higher in number among the four fungi genera observed. It could also be concluded from the result that the rate of involvement of *Penicillium* spp in the spoilage of corn in the field and in the store was high. its dominance could have been that the maize was incorrectly dried, Insufficient drying and precarious condition of storage could promote *Penicillium* spp growth as *Penicillium* spp need water for growth. This agrees with the work of Harrigan *et al.*, (2018) ^[11] who recorded *penecillium* spp higher in his work. It is important to note that *Penicillium* spp. includes diverse producing toxigenic lineage in maize and derived products (Adejumo *et al.*, 2016) ^[2]. It was shown that the predominating fungi genera in the analyzed samples were *Penicillium* spp (42.85%), followed by *Rhizopus* spp. (28.57%), *Aspergillus* spp (14.29%), and *Trichophyton* spp. (14.29%). This research work according to Adejumo *et al.*, (2016) ^[2] has established that corn can spoil under any weather condition. However, the rate and degree of spoilage has been shown to be higher under moist or high humidity conditions. Moreover, all the fungal organisms identified, characterized, and isolated in this study are capable of causing death to man and animals resulting from mycotoxins which they are capable of producing. Also, the results of this study show that the conditions to which corn is exposed in the field and store, as well as the storage method used to preserve it have effects on the type, rate, and extent of infection of the corn by fungi.

Spore Formation, Motility and Biochemical Identification of isolates

Most of the isolates were carbohydrate assimilation, spore formation and Amino Acid Assimilation. The isolation of diverse fungi species from this corn samples foods did not completely agree with the findings of Akinyemi *et al.*, (2019) ^[3] as each author had dissimilarities in fungal presence in their study samples. This present study reported the presence of *Penicillium* spp, *Rhizopus* spp, *Trichophyton* spp and *Aspergillus* spp. The observation of diverse fungal isolates could be attributed to the fact that these samples was carried out at different retailers in the study areas could affect the distribution of organisms. Buyer's attitude towards the exposed food products in the market could also contribute to the fungal load and diversity as they touch the products with bare hands and taste it before they buy. The presence of *Penicillium* spp, in this study calls for concern as this organism is the common cause of human food poisoning, and *Penicillium* spp can affect all species of domestic animals and man. It is important to draw to our attention that the young, aged, stressed, debilitated and pregnant individuals are more susceptible while the immunosuppressed and those suffering from malnutrition are at risk for *Penicillium* spp infection (Akinyemi *et al.*, 2019) ^[3] as the rate and degree of spoilage has been shown to be higher under moist or high humidity conditions.

Conclusion

From this study, it can be concluded that maize can be infected by fungi irrespective of storage condition.

Recommendations

From the findings of this study, the researcher put forward the following recommendations below.

- Proper and effective storage of maize through different techniques should be put in place.
- Public awareness should be increased to sensitized people about the harmful effect of fungi on Maize so as not post harm to them.

Contribution to Knowledge

This study have provided indebt data based information on the effect of fungi spoilage on the nutritional value of corn in Langtang North Local Government Area of Plateau State which other researchers can use for further studies.

Conflict of Interest

The authors have all declared no conflict of interest.

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