Isolation and Identification of Bacillus Cereus and Escherichia coli from Food Sample Sold Within, Kaduna Town

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to isolate and identify Bacillus cereus and Escherichia coli. Bacillus cereus and Escherichia coli were isolated and identified from food samples sold from local food vendors within Kaduna town, Nigeria. This was done using conventional standard method. The molecular characteristics were confirmed by the Polymerase Chain Reaction (PCR) technique. The results of the microscopic characteristics of the isolates revealed that B. cereus is a Gram positive, rod shaped bacterium. The colony of the bacteria appeared rough with dried pink background surrounded by egg yolk precipitate on MYP medium while E. coli appeared Gram negative rod shaped under the microscope. And its colony on plate appeared flat with green metallic sheen on Eosin Methylene Blue (EMB) agar. The biochemical identification showed that B. cereus is positive to haemolysis, catalase, citrate, Vouges Proskauer, motility and spore tests. While E. coli is positive to catalase, indole, methyl red and motility tests and showed a green sheen characteristics on Eosin Methylene blue agar. The PCR showed band at 204bp amplicons of 16S rDNA primer targeting bacterial DNA templates V3 hyper-variable region for B. cereus and E. coli respectively. The amplified DNA was sequenced and BLAST and accession number of KY962911.1 and KY009556.1 were obtained for B. cereus and E. coli respectively.

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Keywords: Bacillus cereus; Escherichia coli isolation; identification.

1. INTRODUCTION

Bacillus cereus has been implicated in food intoxication; it is an opportunistic human pathogen that has been reported to cause local and systemic infections. Food poisoning caused by Bacillus cereus occurs all year round without any ecological distribution [1]. Literatures have associated B. cereus with diarrhea, emetic syndrome and fatal meningitis in humans. Bacillus cereus is a Gram positive, facultative anaerobic, rod shaped, motile, spore formers, catalase positive, beta-hemolytic and does not ferment mannitol [2]. The Spore of Bacillus cereus are widely disseminated and can survive extreme environmental conditions for a long time, it has been recovered from samples of soils, dust, cereal, crops, dirt, and water [3]. Bacillus cereus has a growth temperature range from 10°C to 48°C, with optimal growth between 28°C and 35°C, PH values of 4.9 to 9.3 and water activities of 0.92 to 1.0 [4].

Escherichia coli is a Gram-negative, facultative anaerobic, rod-shaped, coliform bacterium of the genus Escherichia. It is commonly found as a commensal organism in the lower intestine of warm-blooded animals including humans [5]. Although most strains of E. coli have not been associated with disease condition, some serotypes have been implicated in serious food poisoning, following ingestion of contaminated food substances. The harmless strains are part of the normal flora of the gut, and can benefit their hosts by producing vitamin K₂, and preventing colonization of the intestine by pathogenic bacteria [6]. E. coli is expelled into the environment with fecal matter and grows massively in the fecal matter under aerobic conditions for 3 days, but its numbers decline slowly afterwards. E. coli and other facultative anaerobes constitute about 0.1% of gut flora, and fecal–oral transmission is the major route through which pathogenic strains of the bacterium cause disease. This makes them potential indicator organisms to test environmental samples for fecal contamination [5].

The increase rate of food borne diseases is posing a major challenge in the public health sector therefore, this study was carried out to isolate and identify the major bacteria associated with food borne diseases.

2. MATERIALS AND METHODS

2.1 Samples Collection

Food samples were randomly purchased from local food vendors within Kaduna metropoly; samples bought were collected into sterile wide mouth universal bottles with tight-fitting caps. The samples were transported in ice pack thermo-flask to the Medical Laboratory of the Department of Microbiology, Faculty of Science, Kaduna State University for isolation. Food samples purchased were raw meat, roasted meat (Suya), smoked fish, Jollof rice, awara (Soya Cheese).

2.2 Isolation of Bacillus cereus and E. coli

Ten (10) grams of the different food samples were homogenized respectively with 90ml of 0.1% peptone water in a screw capped flasks by means of horizontal and vertical agitation for few minutes and incubated for 24 hours at 37°C. After 24 hours, clear supernatants of homogenized samples were each sub-cultured on freshly prepared plates of MacConkey, and Mannitol Egg Yolk Polymyxin B (MYP) agar plates [7,8]. All cultures were incubated for 24 hours at 37°C [1]. The plates were observed and each positive plate (one to three discrete colonies of presumptive Bacillus cereus and E. coli were sub-cultured on nutrient agar and kept in the refrigerator for further confirmation of the identity of the organism [8].

2.3 Biochemical Tests for Identification of Bacillus cereus and Escherichia coli

Biochemical tests used to identify the isolates include catalase, haemolysis, indole production, methyl red, Vouges-proskauer test, citrate utilization, oxidase test, spore test and motility test respectively [9].

2.4 Molecular Identification

Molecular identification was by the 16s RNA polymerase chain reaction. Molecular confirmation of isolates was determined according to the 16S rRNA gene region. The PCR amplifiability was checked using 16S ribosomal RNA primers V3F-
CCAGACTCCTACGGAGGCCAG and backward V3R-CGTATTACCGCCGCTGTCCTGG.

Extraction was carried out using Extraction buffer (Lifeter Biotech), using manufacturer's protocol. 50μl of the buffer was added to 50μl of isolate solution in molecular biology grade water, and incubated at 100°C for 10minutes using a thermostyler (ABI, Proflex, Life Technologies) and centrifuge at 1300rpm. 5μl of the supernatant was used as template for Polymerase Chain Reaction (PCR). 5μl bacterial Deoxiribo Nucleic Acid (DNA) extract and controls were amplified with 0.5mM primers using 5X Firepol Mastermix ready to load PCR kit (Solis Biodyne). Amplification conditions for PCR were as follows: 5minute at 94°C to denature the DNA, followed by 30 cycles of denaturation at 94°C for 30seconds, primer annealing at 55°C for 40seconds and extension at 72°C for 5minutes on a kyrATECH Supercycler Trinity thermal cycler. Polymerase Chain Reaction (PCR) fragments were separated on a 1% agarose gel and DNA bands were visualized with ethidium bromide staining. The ladder on the agarose gel indicated the intensity of the band to bands of known intensity in a 100Bp DNA Ladder (Promega). The gel was viewed under UV light after fluorescent dye staining. The ladder on the agarose gel indicated the base pair fragment of the DNA of the bacterial. Amplified Polymerase Chain Reaction (PCR) fragments were purified and sequenced with universal primers using Dye Terminator Cycle sequencing kit. Gene sequence chromatograms of the isolates were observed. The similarity search was conducted in-silico using the Nucleotide Basic Local Alignment Search Tool at the National Centre for Biotechnology Institute (NCBI) server. The phylogenetic and molecular evolutionary analyses were conducted using MEGA version 7 (Kumar, Stecher, and Tamura 2016) using the neighbor-joining method.

3. RESULTS AND DISCUSSION

Bacillus cereus is a common soil saprophyte and is easily spread to many types of foods such as dairy products, rice, cereals and cereals derivatives, dried foods, spices, eggs, vegetables and meats [10]. It is also the causative agents of two forms of food poisoning; the diarrhoeal and emetic forms [11], the wide spread of the organism and the ability of its spores to survive dried storage means that most raw and ready to eat foods may contain B. cereus. Bacillus cereus was determined based on the colonial morphology, precipitation of hydrolyzed lecithin around colonies and its failure to utilize mannitol sugar as reported by Mosssel et al. (1967). Generally, the colonies of Bacillus cereus on Mannitol Yolk Polymyxin B (MYP) appeared rough and dried with a bright pink background surrounded by an egg yolk precipitate [7]. According to Abraha et al., [12], B. cereus is a Gram positive (purple coloured), rod shaped cells. Biochemical characteristics of this organism included catalase positive, β-hemolysis on blood agar plate, does not ferment mannitol, it is motile, and spore-forming.

Escherichia coli are bacteria commonly found in the lower intestine of warm blooded organism. Most pathogenic E. coli are transmitted by faecal-oral routes from food materials, water, animals and environment. Food surfaces such as meat, eggs, or fish can be used to isolate E. coli. Phenotypic characterization revealed Escherichia coli ferment lactose on macConkey and produce pink, round medium sized colonies. E. coli appears green metallic sheen color colonies growth on Eosin Methylene Blue (EMB) agar plates. It cellular morphology was revealed to be Gram negative short-rods due to the presence of thin layer of peptidoglycan that made it unable to retain the primary dye. The biochemical characteristic of E. coli was due to it cell wall components and enzyme activity. It was found to be methyl red, indole, citrate positive, and oxidase, and Voges-Proskauer (Whitman et al., 2012). Holt et al., [9] have reported similar phenotypic characteristics. The bacterial species were identified as Bacillus cereus and Escherichia coli using both conventional and molecular methods. The amplified DNA was sequenced and BLAST and the organisms found were similar to those with accession numbers KY962911.1 and KY009556.1 for E. coli and B. cereus respectively.

The molecular characteristics were confirmed by Polymerase Chain Reaction (Fig. 1.). Bands showed 204bp amplicons of 16S rDNA primer targeting bacterial DNA templates V3 hyper-variable region. The bacterial species were identified as Bacillus cereus and Escherichia coli using both conventional (Mosssel et al.,1967) and molecular methods.
**Table 1. Cultural, Cellular and Biochemical Characteristic of the Isolates**

<table>
<thead>
<tr>
<th>Cultural Morphology</th>
<th>Cellular Morphology</th>
<th>Biochemical Characteristic</th>
<th>Most Probable Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rough, dried with pink background surrounded by egg</td>
<td>Gram Positive rod</td>
<td>+</td>
<td>Bacillus cereus</td>
</tr>
<tr>
<td>yolk precipitate on MYP</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Flat colonies with Green metallic sheen, mucoid</td>
<td>Gram negative rods</td>
<td>+ + -</td>
<td>Escherichia coli</td>
</tr>
<tr>
<td>Colonies</td>
<td></td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Key: + = Positive, - = Negative, He = Haemolysis, Ca = Catalase, Cit = Citrate utilization test, In = Indole, Mr = Methyl Red, Vp = Vouges Proskauer, Ox = Oxidase, Mt = Motility, S = Spore, EMB = Eosin Methylene Blue

**Fig. 1.** Agarose gel electrophoresis showing positive bands for *B. cereus* and *E. coli*

**Sequence of *E. coli* and *B. cereus***

*E. coli*

TCAATGGGCACGCTAATGCAGCAGCAGCATGCAGCAGCTGATGAWGAAGGCCTCCTCGGCTTGTAAAGYWCTTTCAKCGGGGARGAAGGGGAAGGAATAGAAAGWTATATMCSTTTGCTCATTGACGKTACCRCASAARAGCMCCCGGCCTAACTCCGTCGCCAGCGCCCGGGTAAATACGAA

*B. cereus*

CCATGCAAGGAGCTGACTCAGGCTAGCGCGCCGTCAGGAGTCATGACGGCGGCTTGGTAAAGYWCTTTCAKCGGGGARGAAGGGGAAGGAATAGAAAGWTATATMCSTTTGCTCATTGACGKTACCRCASAARAGCMCCCGGCCTAACTCCGTCGCCAGCGCCCGGGTAAATACGAA

**Table 2. Molecular Characterization of *Escherichia coli* and *Bacillus cereus***

<table>
<thead>
<tr>
<th>Organism</th>
<th>Maximum Score</th>
<th>Total Score</th>
<th>Query Cover</th>
<th>E-value</th>
<th>Accession Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>307</td>
<td>307</td>
<td>99%</td>
<td>8e-80</td>
<td>KY962911.1</td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>1284</td>
<td>1284</td>
<td>100%</td>
<td>00-00</td>
<td>MG557810.1</td>
</tr>
</tbody>
</table>
4. CONCLUSION

*Escherichia coli* and *Bacillus cereus* were isolated from the food samples sold from food samples within Kaduna, Kaduna state in Nigeria.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCE


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