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ANTIBACTERIAL EFFICACY OF 'OGI' LIQUOR OBTAINED FROM *ZEA MAYS* ON CLINICAL STRAINS OF DIARRHOEAGENIC *VIBRIO* SPECIES

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ABSTRACT

Diarrhoeal infections are a common cause of illness worldwide due to their high rates of morbidity. This study investigated the antibacterial efficacy of 'ogi' liquor on *Vibrio* species associated with diarrhoea. The 'ogi' liquor was obtained in the laboratory from yellow maize (*Zea mays* grains) which was allowed to ferment at ambient temperature of 28±1°C for 72 hours by the maize natural microflora. Proximate analysis, pH and titratable acidity of the 'ogi' liquor was done using standard procedures. The antibacterial activity of the 'ogi' liquor on the test *Vibrio* isolates was carried out using agar well diffusion method. The major component of 'ogi' liquor was found to be its moisture content (72.35%), followed by carbohydrate which is 18.84%. The pH of the 'ogi' liquor decreases ranging from 6.52 to 2.48 while the TTA increases ranging from 0.095 to 0.467%. The 'ogi' liquor had inhibitory effect on most of the *Vibrio* isolates. The highest zone of inhibition was recorded for *V. vulnificus* and *V. alginolyticus* with 17.67 ± 2.52 mm and 16.67 ± 2.08 mm respectively. Ciprofloxacin used as positive control inhibited the growth of all the *Vibrio* isolates. The results obtained from this study showed the antibacterial efficacy of 'ogi' liquor on the test *Vibrio* isolates and therefore could be used in the management of diarrhoea caused by these pathogens.

Keywords: 'Ogi' Liquor, Antibacterial, Diarrhoea, *Vibrio* Species

INTRODUCTION

Diarrhoeal illnesses continue to be a major global cause of death and morbidity, especially in low-resource environments where access to safe water and efficient antibiotic treatment is restricted (Faruque *et al.*, 2018: WHO, 2023). Diarrhoea causes significant loss of fluid and dehydration, which can have serious or even lethal effects if fluids are not replenished (Duport, 2007; WHO, 2023). According Ramamurthy *et al.* (2014), human pathogenic *Vibrio* can cause foodborne disease outbreaks, watery diarrhoea, gastrointestinal disease, and septicemia. These are typically linked to the consumption of contaminated uncooked seafood and the use of water that has been contaminated. Gram-negative, comma-shaped bacteria called *Vibrio* spp. are found naturally in aquatic environments. They move by using a single polar flagellum (Acosta-Smith *et al.*, 2018). According to Letchumanan *et al.* (2014), pathogenic *Vibrio* species including *V. cholerae* and *V. parahaemolyticus* cause acute gastroenteritis and cholera, respectively, with clinical consequences ranging from moderate diarrhoea to potentially fatal dehydration and systemic sequelae. These pathogens are present in contaminated food and aquatic environments and their pathogenicity is mediated by virulence factors such as cholera toxin and specialized secretion systems, which present major global public health issues.

Traditional fermented foods have long been known to provide possible health benefits, such as antibacterial qualities against microorganisms that cause diarrhoea. 'Ogi' is a popular cereal-based gruel in Nigeria that is often produced from maize and other cereals (Ochelle and Sogunle, 2026). In many rural areas, "ogi," a fermented maize porridge from *Zea mays* in West Africa, is both a staple food and a traditional treatment for gastrointestinal disorders (Adebayo-Tayo and Onilude, 2008). Many rural communities depend on medicinal plants and other natural resources for healthcare because conventional medical services are often inaccessible. Uncooked pap slurry liquor, a fermented cereal-based Nigerian food product derived primarily from maize (*Zea mays*), is traditionally used by rural people in some communities in Southwest Nigeria to cure diarrhoea and stomach discomfort (Yusuf, 2021). The fermentation process of 'ogi' encourages the growth of lactic acid bacteria (LAB), which lower pH and provide an unfavorable environment for many pathogenic bacteria by producing organic acids, hydrogen peroxide, and bacteriocins (Nout, 2009).

Previous research has reported the antibacterial effects of the liquor fraction of fermented 'ogi' on common diarrhoeal bacteria such as *Escherichia coli*, *Shigella dysenteriae*, *Salmonella typhimurium*, and *Staphylococcus aureus*, where natural fermentation metabolites exhibited inhibitory activity in agar diffusion assays (Adebolu *et al.*, 2007). According to Adebayo-Tayo *et al.* (2006), the liquor produced by "ogi" fermentation shows inhibitory effects against microorganisms that cause diarrhoea, such as *Salmonella typhi*, *Shigella dysenteriae*, *E. coli*, and *S. aureus*. Similar antibacterial effects have been noted in fermented cereal products, where bacteriocins and acidic metabolites inhibit the growth of pathogens (Nout, 2009). Additionally, Adebolu and Adaramola (2012) observed that the inhibition is significantly influenced by the mode of fermentation, whether it is continuous or discontinuous every 24 hours at 30 ± 2°C.

Despite the evidence supporting 'ogi' wide antibacterial potential, the efficacy of "ogi" against clinical strains of *Vibrio* species has not been thoroughly investigated. Examining the antibacterial qualities of fermented foods like 'ogi' against *Vibrio* spp. may provide accessible, food-based remedies that supplement traditional therapy, given the prevalence of diarrheal illness worldwide and the increasing resistance of enteric pathogens to antibiotics. With implications for functional food applications and public health measures in areas where these diseases are widespread, this study aims to close that gap by evaluating the antibacterial activity of "ogi" liquor made from *Zea mays* against clinical strains of diarrhoeagenic *Vibrio* species.

MATERIALS AND METHODS

Study Area

The organisms used for this study were previously isolated from diarrhoeic stool samples of patients attending Federal University of Technology Teaching Hospital, Akure, Ondo State, South Western Nigeria. Akure is the Ondo State capital and covers an area of 14,798.8, 993.7 square kilometers, it lies at latitude 7°15′0″N, 70 11′ N 5°11′42″E and longitude 5°11′42'E, 5°35'E (Onifade *et al.,* 2019).

Test Organisms

The test organisms: *Vibrio vulnificus, Vibrio parahaemolyticus, Vibrio alginolyticus* and *Vibrio damsella* used in this study were obtained from Department of Microbiology at Federal University of Technology, Akure, Ondo State. Identification of the *Vibrio* isolates was confirmed using standard laboratory techniques, including cultural characteristics, morphological examination, biochemical tests, and polymerase chain reaction (PCR) assays.

Collection of Maize Grains

Yellow maize grains (*Zea mays*) used in this study were purchased from an open market in Ipetu-Ijesa, Osun State, Nigeria.

Preparation of 'Ogi'

This was prepared according to the method of Adebolu *et al.* (2018). The maize grains used were sorted to remove pebbles, moldy and deformed grains followed by washing in sterile distilled water to remove dirt and surface contaminants. One kilogram of the clean grains were steeped in clean water that sufficiently covered the grains inside a clean plastic bucket with a cover and left at room temperature (30±2°C) for 72 h. The grains were washed in three changes of clean water and wet-milled using a local grinding machine. The resulting paste was sieved with a clean muslin cloth and the filtrate was collected into a clean plastic bucket with cover. The filtrate was allowed to settle at 30±2°C for 72 h for natural fermentation to take place. After the filtrate had settled, the supernatant liquid was referred to as the liquor, while the sediment was referred to as the slurry.

Proximate Analysis of 'Ogi' Liquor

Fat content, moisture content, crude fiber, total ash and total protein of 'ogi' liquor were determined according to the method of AOAC (2012). The total carbohydrate content was estimated by difference. The sum of the moisture, ash, crude fiber, fat and protein of the 'ogi' liquor was subtracted from 100 to obtain the percentage carbohydrate (AOAC, 2012).

Determination of pH and Titratable Acidity (TTA) pH

The pH of ''ogi'' liquor was determined at the 0, 24, 48, 72, 96 and 120 hours of fermentation. This was carried out by standardizing the pH meter in buffers 4.0 and 6.0 and thereafter dipping the probe into the samples, until the meter read a stable value pH (Prescott *et al.,* 2005)

Titratable Acidity

Titratable acidity (TTA) of the liquor was determined at 0, 24, 48, 72, 96 and 120 hours of fermentation as described by Adebukunola *et al.* (2018). Ten milliliter (10 ml) of liquor was dispensed into separate conical flasks and 2 drops of phenolphthalein indicator was added. The content of the flask was thoroughly mixed using a sterile glass stirring rod and titrated against 0.1M NaOH. The appearance of a pink colour marked the end point of the reaction.

Antibacterial Activity of the Prepared 'ogi' Liquor

The surface of the Mueller Hinton agar plate was inoculated with the test organisms. Inoculum was standardized by matching the turbidity with 0.5% McFarland standard. With a sterile cotton swab stick, the test culture was spread evenly over the plate successively in three directions to obtain an even inoculum. Wells (6 mm in diameter) were bored on the inoculated agar plate using a sterile cork borer, 0.2 ml of the liquor of maize 'ogi' of 72 hours fermentation days was introduced into the wells accordingly. Sterile distilled water and ciprofloxacin was used as a negative control and positive control respectively, and the plates were carefully incubated at 37°C for 24 hours. Zones of inhibition were carefully measured after 24 hours and were properly recorded as described by Yusuf (2021)

RESULTS AND DISCUSSION

The proximate composition of the 'ogi' liquor is shown in Figure 1. The moisture content was the highest with 72.35%, followed by carbohydrate content with 16.84%. Crude fibre and ash contents were the lowest with 0.745% and 0.815% respectively.

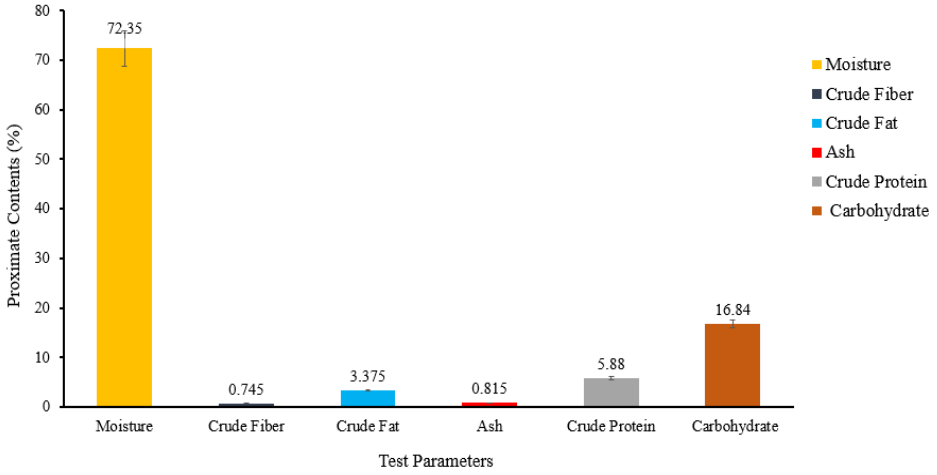

Figure 1: Proximate Composition of 'Ogi' Liquor

Table 1 shows the result of the pH and total titratable acidity (TTA) of the 'ogi' liquor. The total titratable acidity ranged from 0.095 to 0.467%. This shows that lactic acid was present in the various liquors. The pH of the liquor also ranged from 2.48 to 6.52. The pH of the liquor decreased from 6.52 at 0 hour) to 2.48 at 120 hours while the total titratable acidity increased from 0.095% at 0 hour to 0.467% at 120 hours.

Table 1: Titratable Acidity and pH of 'Ogi' Liquor

Fermentation Time	Titratable acidity (TTA) (%)	pH
0 Hour	0.095 ± 0.003^{a}	6.52 ± 0.33^{a}
24 Hours	0.335 ± 0.002^{b}	3.88 ± 0.05^{b}
48 hours	0.417 ± 0.004^{c}	3.06 ± 0.04^{c}
72 hours	0.434 ± 0.004^{d}	2.85 ± 0.04^{d}
96 hours	0.447 ± 0.007^{e}	2.83 ± 0.03^{e}
120 hours	0.467 ± 0.002^{f}	2.48 ± 0.11^{f}

The antibacterial activity of 'ogi' liquor against *Vibrio* species is shown in Table 2. The 'ogi' liquor had inhibitory effect on all the *Vibrio* isolates tested except *Vibrio alginolyticus* VV3. The zone of inhibition recorded ranged from 10.00±1.00 to 17.67±2.52 mm. The highest zone of inhibition was observed against isolate *V. vulnificus* (VV3) (17.67 ± 2.52 mm), followed by *V. alginolyticus* (VG2) (16.67 ± 2.08 mm). The highest zone of inhibition (17.67±2.52) was found against *V. vulnificus* VV3. Ciprofloxacin, used as the positive control inhibited the growth of all *Vibrio* isolates at 0.1mg/ml with zone of inhibition ranging from 12.00 ± 2.00 mm to 28.33 ± 1.53 mm.

Table 2: Antibacterial Activities of 'Ogi' Liquor against Selected *Vibrio* Species

	Zone of Inhibition (mm)		
Organism	**Liquor**	**Ciprofloxacin**	**Sterile Distilled water**
VV1	11.33 ± 1.53^{b}	12.00 ± 2.00^{a}	0.00 ± 0.00^{a}
VV2	10.00 ± 1.00^{b}	11.33 ± 1.53^{a}	0.00 ± 0.00^{a}
VV3	17.67 ± 2.52^{d}	28.33 ± 1.53^{e}	0.00 ± 0.00^{a}
VV4	13.00 ± 1.00^{bcd}	24.67 ± 1.53^{de}	0.00 ± 0.00^{a}
VG1	13.33 ± 1.53^{bcd}	23.33 ± 1.53^{cd}	0.00 ± 0.00^{a}
VG2	16.67 ± 2.08^{cd}	19.67 ± 1.53^{bc}	0.00 ± 0.00^{a}
VG3	0.00 ± 0.00^{a}	18.33 ± 1.53^{b}	0.00 ± 0.00^{a}
VG4	12.00 ± 2.00^{bc}	23.00 ± 1.00^{bcd}	0.00 ± 0.00^{a}
VP1	13.00 ± 2.00^{bcd}	22.33 ± 1.53^{bcd}	0.00 ± 0.00^{a}
VP2	12.00 ± 1.00^{bc}	21.33 ± 1.53^{bcd}	0.00 ± 0.00^{a}
VD1	11.33 ± 1.53^{b}	12.33 ± 2.08^{a}	0.00 ± 0.00^{a}
VD2	11.00 ± 2.65^{b}	21.33 ± 1.53^{bcd}	0.00 ± 0.00^{a}

Values represent means ± standard deviation of triplicate readings. Superscripts of the same letter in a row are not significantly different at $P\leq0.05$.
VV = *Vibrio vulnificus*, VG = *Vibrio alginolyticus*, VP = *Vibrio parahaemolyticus*, VD = *Vibrio damsella*

Discussion

Comparatively, the moisture content of the 'ogi' liqour recorded in the present study was observed to be higher than the value (8.53–9.79 g/100 g) reported by Emelike *et al.* (2020) for 'ogi' slurry developed from maize enriched with ginger and cinnamon. Ijarotimi *et al.* (2022) also reported a lower moisture content for 'ogi' slurry made from selected cereal grains. Similarly, ojo *et al.* (2023) reported a lower moisture content ranging from 12.15 to 13.73% in 'ogi' prepared from a mixture of cereal grains. The high moisture content observed in this study is expected because 'ogi' liquor is a fermented aqueous extract obtained during the wet-milling and fermentation of cereals. High moisture content has been associated with increased microbial activity and shorter shelf life of fermented products due to the availability of water required for microbial metabolism (Tapia *et al.*, 2020). The total ash content recorded is lower than the ash content of 0.93 to 0.99 g/100g reported by Ijarotimi *et al.* (2022) in their 'ogi' slurry samples. Ojo *et al.* (2023) also reported a higher ash content of 1.57 to 2.69% in ogi slurry flour. This might be due to the higher mineral contents that is present in 'ogi' slurry compared to the liquor. On the contrary, Emelike *et al.* (2020) reported lower ash content (0.19 to 0.27 %) in slurry of spiced 'ogi' samples. Crude fibre content of the 'ogi' liquor from this study is low and this is comparable with those reported for ginger and cinnamon-spiced 'ogi' samples (0.29 – 0.81%) as reported by Emelike *et al.* (2020). Ojo *et al.* (2023) also reported a higher crude fibre content of 3.62 to 5.34% in ogi slurry Also, Olaniran and Abiose (2018) reported a higher crude fibre content of 3,05 to 3.65% in 'ogi'i spiced with ginger and garlic which is contrary with this study. The crude fibre is higher in the 'ogi' slurry when compared to the liquor because during processing, crude fibre is s largely insoluble substance that does not dissolve into the liquor, it rather remains in the solid phase (slurry) that gets sieved out.

The total titratable acidity of the 'ogi' liquor, measured as percentage lactic acid, increased as the fermentation time increased. This shows that lactic acid was present in the liquor. A similar trend was reported by Abdus-Salaam *et al* (2014) who stated that titratable acidity increased from 0.14 on day 1 to 0.23 on day 4. Adebolu *et al.,* (2018) also reported an increase in TTA from 6.00 to 11.13 as the fermentation time progresses which is in line with this study. The low pH of the liquor could be partly responsible for the inhibition because most bacteria cannot grow at low pH except a few such as the *Lactobacillus plantarum*, (Abdus-Salaam *et al.*, 2014). The pH of the liquor decreased as the fermentation

time increased. This is because of the increase acidity of the medium. Therefore, acidic conditions are unsuitable for the survival of certain organisms, leading to their death, while only acid-tolerant organisms, such as acidophiles, are able to persist (Gonzalez-Toril *et al.*, 2003). Earlier reports have shown that most bacteria cannot grow at low pH (Adebolu *et al.*, 2007).

'Ogi' liquor used in this study demonstrated antibacterial activities against most of the *Vibrio* isolates, this was evident by the clear zones of inhibition produced by the liquor on the bacteria growth. In this study, the highest antibacterial activity was observed against *Vibrio vulnificus* (VV3), while the least inhibition was on *V. vulnificus* (VV2). This suggests that the susceptibility of *Vibrio* species to fermented products may vary among strains due to differences in cell wall structure, resistance mechanisms, and physiological adaptations. Similar strain-dependent susceptibility patterns among *Vibrio* isolates have been reported by Elbashir *et al.* (2018). Abdus-Salaam *et al.* (2014) reported a higher inhibition by five-day old corn steep liquors against *E. coli* and *V. parahaemolyticus*. The observed antibacterial activity indicates that 'ogi' liquor contains antimicrobial metabolites capable of suppressing the growth of pathogenic *Vibrio* species. However, no inhibitory effect was observed against isolate *V. alginolyticus* (VG3), suggesting possible resistance or reduced susceptibility. The resistance observed in *V. alginolyticus* (VG3) may be due to intrinsic resistance mechanisms such as efflux pumps, reduced membrane permeability, or enzymatic detoxification of antimicrobial compounds. On the contrary, Ghannay *et al.* (2022) reported that *Cuminum cyminum* L. essential oil had an inhibitory effect on the growth of *V. alginolyticus*. Similarly, Andriyono *et al. (*2022) demonstrated that methanol crude extract of *Phyllophorus* sp. exhibited antibacterial activity against *V. alginolyticus*. According to Letchumanan *et al.* (2014), some *Vibrio* strains possess adaptive mechanisms that enhance survival under acidic and antimicrobial stress conditions. To the best of my knowledge, direct studies on the antibacterial potential of 'ogi' liquor on *Vibrio* spp. are fewer than those on other diarrhoeal pathogens like *Escherichia coli, Salmonella*, or *Shigella*. Shittu *et al.* (2016) reported in their findings that 'ogi' liquor demonstrated clear *in vitro* vibriocidal activity against *V. cholerae*. Adebolu *et al.* (2007) reported that 'ogi' liquor had an inhibitory effect on the growth *of Shigella dysenteriae, E. coli, Salmonella typhimurium*. Similarly, Adebolu *et al. (*(2018) reported that 'ogi' demonstrated antibacterial activity against dairrhoegenic *E. coli*. Yusuf (2021), also showed the antibacterial efficacy of maize pap slurry liquor i*n vitro* on *Escherichia coli, Salmonella tyhpi*, and *Shigella dysenteriae*. The broad activity against Gram-negative enteric pathogens suggests potential cross-efficacy of the 'ogi' liquor. Ciprofloxacin, used as the positive control, exhibited the highest zones of inhibition against all the *Vibrio* isolates, thus confirming the susceptibility of the test organisms.

In this study, the observed antibacterial activity of the 'ogi' liquor may be attributed to inhibitory compounds produced by Lactobacilli such as organic acids, diacetyl, hydrogen peroxide, nisin, lactic acid, and bacteriocins (Caplice and Firzgeral, 1999; Ayeni *et al.*, 2009; Afolayan *et al.*, 2018; Adeiza *et al.*, 2025). Previous studies have reported the effectiveness of *Lactobacillus* species against enteropathogenic bacteria (Ayeni *et al.*, 2011; Adeoshun and Ayeni, 2016; Kwasi *et al.*, 2019). Furthermore, the decrease in pH contributes to the inhibitory effect of the 'ogi' liquor on *Vibrio* species. These acidic conditions can inhibit bacterial growth by disrupting cell membrane integrity and metabolic functions. Afolayan *et al.* (2017) and Adebolu *et al.* (2018) reported a drastic change in the pH of the fermenting 'ogi' liquor, which is consistent with this study.

CONCLUSION

The result from this study showed that 'ogi' liquor from maize (*Zea mays*) possess antibacterial activities against the *Vibrio* isolates associated with diarrhoeal infections. The findings revealed that 'ogi' liquor inhibited most of the test organisms, although its efficacy varied among isolates, indicating strain-dependent susceptibility. The increase in titratable acidity and decrease in pH contributed to the antimicrobial properties of the 'ogi' liquor. The findings of the study support the potential of 'ogi' liquor as a natural source of antimicrobial agents in the management of diarrhoeal diseases. Therefore, further investigation should be conducted to isolate, identify and characterize the bioactive compounds in the 'ogi' liquor.

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