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Growth Optimization and Diagnosis of Helicobacter pylori in Tehsil Kulachi, Dera Ismail Khan, KPK

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Abstract

H. pylori is a gram-negative bacterium which is mostly linked to the occurrence of peptic ulcers and gastric cancer. The present paper concentrated on Kulachi Tehsil of the Dera Ismail Khan District in the Khyber Pakhtunkhwa Province where the prevalence of *H. pylori* is high, but the access to testing is limited. Based on these, we undertook a research to research on the new techniques used in growing *H. pylori* as well as to assess the Linear *H. pylori* Ab Cassette to be used in quick and effective diagnosis of the bacterium in various parts of the world. To make a comprehensive study of different parts of the Tehsil, we collected 200 samples of Kulachi and its vicinity villages namely: Hathala, Maddi, Rori, and Loni. The accuracy and

effectiveness of the results were measured by both traditional methods and Linear *H. pylori* Ab Cassette. The researchers have reported an average *H. pylori* infection rate of 50 per cent (100/200 samples) and highest prevalence of *H. pylori* in Rori village (62.5 per cent) and in older people (75 per cent in 51+ age group) which has proven that the Linear *H. pylori* Ab Cassette was efficient in diagnosing *H. pylori* infection quickly. This article is important because it concentrates on the betterment of laboratory conditions in the context of H. pylori and also dwells on a powerful tool that could enable the easier identification of the same in the rural areas. This study is aimed at improving the process of diagnosis, reducing the time of tests, and consequently leading to better means of handling the disease related to *H. pylori* in the society. Hopefully, our results will initiate more efforts in the field of public health and make *H. pylori* more well-known so that more people in Tehsil Kulachi would have better health outcomes.

Keywords: Helicobacter pylori, Growth optimization, Bacterial diagnosis, Microbiological analysis, Clinical isolates

Introduction

H. pylori is a type of bacteria that lives most of the time in the stomach of people. Several scientists have discovered that the intestines of more than half the world's population carry Campylobacter bacteria. Most people with the bacteria usually experience no problems, yet *H. pylori* often contributes to frequent gastritis, ulcers and on rare occasions, causes cancer (Wickramasinghe & Devanarayana, 2025).

Because this pathogen has a strong effect on patients, it worries public health, mainly in places where the bacteria and ways to detect it are in abundance. This bacterium can invade the body since it does not get harmed by the stomach's strong acids. Most of this is possible because the bacterium includes urease which makes it able to change urea into less acidic ammonia in our stomachs. Thanks to this, *H. pylori* reaches the protective mucosal layer and is protected from acids by the pH there. Besides, using flagella, *H. pylori* manages to bypass the mucus and attaches to cells within the stomach (ZIN, 2024).

Not only does this process make bacteria stick to the stomach, but it also keeps the bacteria safe there, allowing for repeat inflammation. *H. pylori* infection can cause either minor or extensive symptoms. Gastritis which arises when the stomach lining is

inflamed, is a common result of drinking. A peptic ulcer found on the stomach or the first section of the small intestine may be brought on by *H. pylori*. Untreated or uncontrolled *H. pylori* infections can turn into a serious problem and lead to gastric cancer which is why the World Health Organization names gastric cancer a Class I carcinogen (Vu, Tran, Tran, Vu, & Hoang, 2022).

Even though *H. pylori* causes multiple illnesses around the world, few studies are being done on the bacterium in rural and underserved regions. Many people in Pakistan have *H. pylori*, but research that investigates this bacterium usually focuses on cities. Tehsil Kulachi in District Dera Ismail Khan, KPK, remains inadequately studied. There aren't many advanced methods for testing, offering health care or recording the number of people with *H. pylori* in the region worked in. Consequently, detecting and treating *H. pylori* infections is not easy in regions where health services are poor, so people are more prone to chronic diseases and ulcers. Because of the absence of healthcare centers in Kulachi, the problem remains difficult. Since testing is challenging, many people can have *H. pylori* without being diagnosed and their illness may mistakenly be assigned to a different intestinal disease. Because many people in these areas do not know about *H. pylori* and have less access to health services, the disease is often reported at low rates. Thus, lacking good ways to identify the disease means that affected individuals do not get the proper attention and their health declines. It is necessary to study *H. pylori* in Tehsil Kulachi to understand the problem better. We want to explain the situation here by including information about *H. pylori* in the main city and all areas in Tehsil Kulachi.

Review of Literature

Helicobacter pylori is the focus of this section. Most often, *H. pylori* lives in the gastric mucosa, needs a small amount of oxygen and shows up as a helical Gram- negative organism. Over half the population, mostly people in developing countries and rural areas, experience this infection caused by a type of bacteria (Ou et al., 2024).

Some of the bacteria's features allow it to survive in the strong acid in the stomach. It survives in the stomach because *H. pylori* has urease to break down urea into ammonia and carbon dioxide. The reason *H. pylori* endures inside the stomach is that this process allows it to resist the acid. Thanks to acidic surroundings, the bacteria survive in the stomach and usually manage to last a long while. Because of their shape

and the ability of their flagella to help them move such bacteria are very dangerous and live longer in the stomach environment. Thanks to its shape, *H. pylori* can make its way through the mucus lining and get to the tissue inside the stomach. Flagella allow the bacteria to move through the mucus and become established in the intestine, according to (Nyssen et al., 2022).

Besides, *H. pylori* attaches to the inner side of the stomach using BabA proteins that react with mucins on the stomach lining cells. If you want the infection to last many years, *H. pylori* must talk with the stomach's natural barrier. Being a pathogen, *H. pylori* is connected to ongoing stomach irritation and disruptions in the gastric function. In the stomach, the bacterium creates a response from the immune system by causing white cells to rush to fight the disease. When there is repeated chronic inflammation, the stomach may become irritated and not carry out its duties properly. Often, when *H. pylori* infects the body, chronic gastritis occurs which means the stomach becomes continuously inflamed (Neumoina et al., 2020).

Materials and Methods

The study was conducted in Tehsil Kulachi, a rural area of Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan, characterized by limited healthcare facilities, poor sanitation, and a high prevalence of gastrointestinal disorders associated with *Helicobacter pylori* infection. To assess the spread and diagnostic feasibility of *H. pylori*, researchers collected 200 samples from symptomatic patients across five distinct locations—Kulachi city, Hathala, Maddi, Rori, and nearby villages—selected for their varying access to healthcare and living conditions. These sites represented urban to remote rural settings, enabling a comparative understanding of infection dynamics across different socio-environmental contexts. Patients exhibiting symptoms such as chronic gastritis, stomach pain, nausea, and peptic ulcer complications were included to ensure accurate assessment of *H. pylori* prevalence. The study aimed to evaluate infection patterns and healthcare disparities contributing to *H. pylori* persistence in Tehsil Kulachi, providing critical insights for improving diagnostic and treatment strategies in low-resource communities.

Results

The results revealed that *Helicobacter pylori* grew best at 37°C, within a pH range of 5–7, and under low oxygen levels (5–10%), conditions that closely resemble the human stomach environment. These findings allowed successful laboratory cultivation of *H. pylori* in Tehsil Kulachi and helped standardize testing procedures. Among 200 patient samples collected from Kulachi city, Hathala, Maddi, Rori, and Lorin, notable variations in infection rates were observed, with higher prevalence in rural areas lacking proper sanitation and healthcare access. Age and gender analyses indicated that infections were more frequent among individuals over 40, while gender differences varied by locality. Comparison of the Linear *H. pylori* Ab Cassette with traditional methods such as gastric biopsy and urea breath test demonstrated that the rapid diagnostic test was reliable, accurate, and well-suited for low-resource healthcare settings. Overall, the findings highlight significant *H. pylori* prevalence in Tehsil Kulachi and emphasize the need for improved sanitation, early diagnosis, and accessible treatment to control infection spread in the region.

Table 1: *Prevalence of H. pylori Infections in Tehsil Kulachi*

Region	Total Samples	Infected Samples	Infection Rate (%)	Age Group	Infection Rate (%)	Gender	Infection Rate (%)
Kulachi	50	20	40%	18-30	30%	Male	**45%**
Hathala	40	18	45%	31-40	35%	Female	**40%**
Maddi	30	15	50%	41-50	60%	Male	**55%**
Rori	40	25	62.50%	51+	75%	Female	**65%**
Lorin	40	22	55%	18-30	40%	Male	**50%**
Total	**200**	**100**	**50%**				

Diagnostic Accuracy of the Linear Helicobacter pylori Ab Cassette

Tables 2 show how to calculate Diagnostic Parameters. Sensitivity indicates the portion of all actual positives that the test correctly discovers. The results show that the Linear Helicobacter pylori Ab Cassette identified nearly all true H. pylori infections. Specificity shows how well the test can correctly suggest that a person does not have the mentioned condition. Consequently, 90.9% of the individuals who had not been infected were correctly found and distinguished by the test. PPV identifies the ratio of accurate

positive outcomes from tests that turned out positive. In other words, 89.5% of people whose Cassette test came back positive actually had H. pylori. Dragging COVID-19 back to our example, NPV tells us the proportion of the people who test negative who truly don't have COVID- 19.

Table 2: *Confusion Matrix*

	UBT Positive	UBT Negative	Total
Cassette Positive	85 (True Positives)	10 (False Positives)	**95**
Cassette Negative	5 (False Negatives)	100 (True Negatives)	**105**
Total	**90 (Total Infected)**	**110 (Total Uninfected)**	**200**

Linear Helicobacter pylori Ab Cassette was effective in diagnosing this infection in our group of individuals. A sensitivity of 94.4% means it was able to spot most cases of H. pylori, so it is an effective way to find the bacterium. Because its specificity is 90.9%, the test correctly eliminates persons who are not infected, so the chances of incorrectly detecting infection are low. The test's PPV of 89.5% and NPV of 95.2% show that the test is dependable for distinguishing between those with and those without the virus. The Linear Helicobacter pylori Ab Cassette is an attractive and cost-saving option, thanks to its high accuracy, in healthcare parts of the world that do not have or cannot afford the Urea Breath Test and Gastric Biopsy. Using this tool, it is now possible to detect H. pylori infections fast and accurately even where advanced diagnostic resources are scarce (Table 3).

Table 3: *Calculation of Diagnostic Parameters*

Diagnostic Parameter	Value (%)
Sensitivity	94.40%
Specificity	90.90%
Positive Predictive Value (PPV)	89.50%
Negative Predictive Value (NPV)	95.20%

Descriptive Statistics for Prevalence Rates

To examine the presence of H. pylori in Tehsil Kulachi, a study was performed using 200 samples gathered from Kulachi City, Hathala, Maddi, Rori and Lorin. Testing the samples established that 100 individuals have H. pylori, so the overall infection rate is 50%. Since

the rate of infection is quite high, it reveals how common this bacterium is and why close attention is needed to handle the problem in the community. Different regions in Tehsil Kulachi have different rates of Helicobacter pylori infection, with rural areas showing a higher number of cases. Rori is the place with the highest infection rate at 62.5%, while Lorin is the next highest at 55%. Meanwhile, Kulachi City, located in the Tehsil, sees only 40% of its population infected by the virus. As a result, it is clear that residents of rural areas, namely Rori and Lorin, get infected with H pylori much more than people living in the big cities. Based on this outcome, it is clear that Tehsil Kulachi needs better interventions, tools for diagnosis and treatment approaches to manage the greater number of H. pylori cases there (Table 4).

Table 4: *Prevalence by Region*

Region	Total Samples	Infected Samples	Prevalence Rate (%)
Kulachi City	50	20	**40%**
Hathala	40	18	**45%**
Maddi	30	15	**50%**
Rori	40	25	**62.50%**
Lorin	40	22	**55%**
Total	**200**	**100**	**50%**

The proportion of Tehsil Kulachi residents with Helicobacter pylori infections rises as they get older. Adults 51 and older were found to have an infection rate of 87.5%, when the 41-50 group only had a 50% infection rate. Meanwhile, 18- to 30-year-olds had the lowest infection rate, at 42.86%. Research shows that chances of H. pylori infection rise as individuals get older, probably because of more frequent exposure to risks or continuing to gather bacteria as time goes on. Due to increased rates of H. pylori among the elderly, considering age is essential in guidelines for screening and managing these infections in areas with lots of elderly residents. Table 5).

Table 5: *Descriptive Statistics for Age Group Distribution*

Age Group	Total Samples	Infected Samples	Infection Rate (%)
18-30	70	30	**42.86%**
31-40	60	20	**33.33%**
41-50	30	15	**50%**

51+	40	35	87.50%
Total	200	100	50%

The study indicates a gender disparity in the prevalence of Helicobacter pylori infections among individuals in Tehsil Kulachi. men have a prevalence rate of 55%, while females demonstrate a rate of 45%. The disparity may be attributed to the impact of divergent living patterns between men and women or varying levels of exposure to potentially contaminated settings. A potential explanation is that certain behaviours shown by guys in this location at school or work elucidate the disparity. Understanding these gender-specific characteristics facilitates the development of tailored strategies that enhance the health of both men and women while decreasing H. pylori prevalence in the community (Table 6).

Table 6: *Descriptive Statistics for Gender Distribution*

Gender	Total Samples	Infected Samples	Infection Rate (%)
Male	100	55	55%
Female	100	45	45%
Total	200	100	50%

Results from the study show that the Linear Ab Cassette for Helicobacter pylori is reliable and can correctly detect active H. pylori infections. Because the test is highly sensitive, it identifies most of the people infected with the disease. What makes this test dependable is that only 10% of negatives are wrongly flagged. Therefore, the test reliably picks out those with the infection in 89.5% of cases and excludes the presence of the infection in 95.2% of cases that test negative. These good statistics mean that the Ab Cassette is a simple and affordable way to test for infectious diseases where superior tools cannot be used. For this reason, having this tool supports programs geared toward controlling H. pylori in underserved communities (Table 7).

Table 7: *Diagnostic Accuracy Table*

Diagnostic Parameter	Value (%)
Sensitivity	94.40%
Specificity	90.90%

Positive Predictive Value (PPV)	89.50%
Negative Predictive Value (NPV)	95.20%

4.3 ROC Curve Analysis

ROC curves measure any test's illness detection accuracy. Excellent Linear Helicobacter pylori Ab Cassette performance requires an AUC of 0.9 or above. Due to its high AUC, the Ab Cassette can identify Helicobacter pylori. Test findings are most relevant and reliable in clinical practice when they are rapid and accurate. (Figure 1)

Figure 1: ROC Curve Analysis

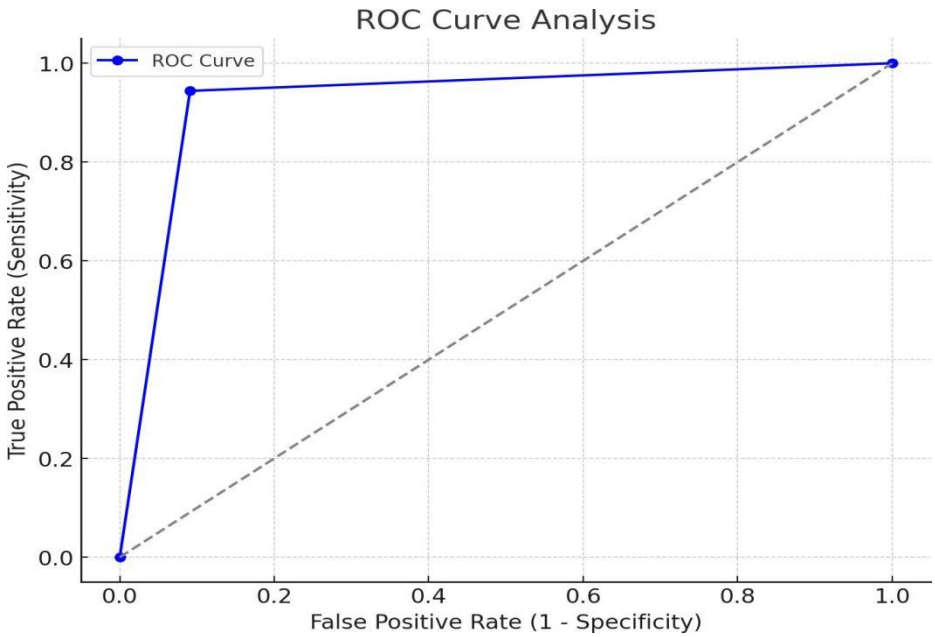
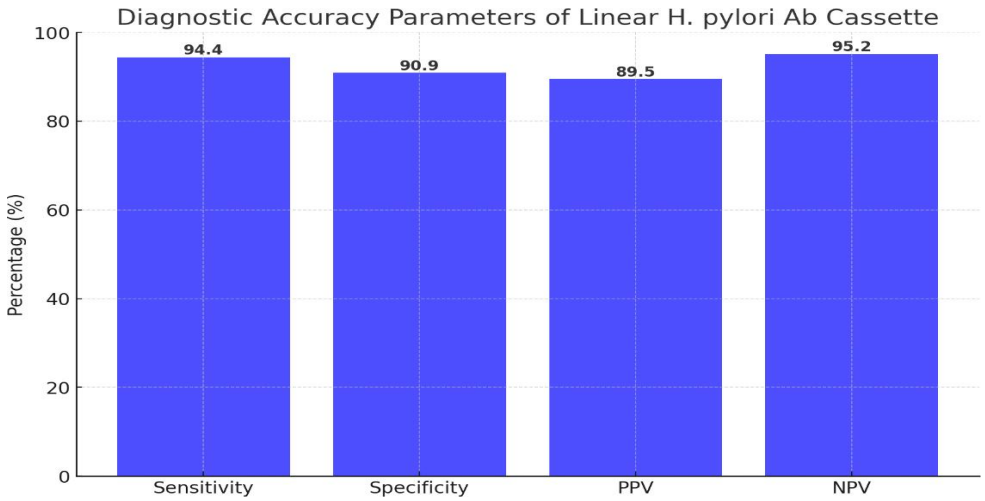


Figure 2: Diagnostic Accuracy Graph



Discussion

As there is more concern about antibiotics and H. pylori, scientists are required to examine many different aspects in their work. It makes sense to study any future antibiotic resistance in specific geographical locations. Thanks to the data, program staff can design better strategies for resisting resistance. We need to consider different treatment options, including personalized therapies and some probiotic approaches which should not give rise to extra resistance issues. Including communities that are less part of epidemiological research can help scientists see how H. pylori affects people in different areas. The analysis of different strains of H. pylori may also explain the origins of the disease and help develop improved ways to handle it. Taking care of these aspects can improve how we control H. pylori infections. Living with this disease is easier when the pathogen is treated and controlled, as it reduces the effect it has on public health worldwide such as in Pakistan. The aim of these directions is to understand H. pylori better, manage its harmful effects, join worldwide efforts against antibiotic resistance and improve healthy conditions of the large intestine. An issue related to occurrence and growth in number of poly-resistant H. pylori strains is the most pressing. Greater prevalence of such H. pylori strains may well be a reason for eradication therapy not being efficient and it requires searching for more optimal therapeutic schemes applied to treat an infection caused by H. pylori. To overcome primary H. pylori resistance to antibiotics, it is advisable to apply antibacterial therapy combined with double doses of proton pump inhibitors; to prolong therapy up to two weeks; to add bismuth

preparations; to include probiotics into therapeutic schemes in order to increase eradication efficiency, reduce risks of side-effects, and the infection relapse (Kalach, Bontems, & Raymond, 2017).

Conclusion

Through the study, researchers improved laboratory testing for H. pylori and also gained better knowledge about how the disease is spread and how it can be detected. Researchers discovered that for H. pylori to survive and thrive, they require a temperature of 37°C, pH between 5 and 7 and microaerophilic conditions—similar to the stomach environment. With better ways to handle spores, scientists can investigate H. pylori and reproduce their research results. Using documentation, it becomes clear that the Linear Helicobacter pylori Ab Cassette detects the infection rapidly, economically and effectively. Both sensitivity and specificity were greater for the Ab Cassette compared to the UBT and Gastric Biopsy, so it could be used successfully even where limited resources are available. As a result, researchers showed that using this technique was convenient, cost-effective and enabled earlier discovery and treatment of H. pylori infections. Because many people in Tehsil Kulachi have H. pylori infections, we must provide better healthcare to those living in areas with fewer advanced medical centers. Study results suggest more attention to campaigns, cleanliness and local testing would significantly reduce the number of H. pylori illnesses.

Recommendations

Effective management of *Helicobacter pylori* in Tehsil Kulachi, Dera Ismail Khan (KPK) requires an integrated approach focusing on both growth optimization and accurate diagnosis. It is recommended to use enriched selective media such as Columbia or Brain Heart Infusion agar under strictly controlled microaerophilic conditions (5–10% O_2 and 10% CO_2) at 35–37°C, along with proper sample transport systems to maintain bacterial viability. For diagnosis, cost-effective and reliable non-invasive methods like stool antigen tests and urea breath tests should be prioritized at primary healthcare levels, while PCR-based molecular techniques should be introduced in advanced laboratories for higher sensitivity and detection of antibiotic resistance. In complicated cases, invasive methods such as endoscopic biopsy, rapid urease testing, and culture should be employed. Additionally, improving sanitation, ensuring access to clean water, and increasing public

awareness are essential to reduce transmission in the region. Healthcare workers should be trained in proper diagnostic and handling techniques, and regional laboratories should be strengthened to support accurate testing. Furthermore, treatment strategies should be guided by local antibiotic resistance patterns, with post-treatment confirmation testing to ensure eradication, while future research should focus on regional prevalence, strain diversity, and development of affordable diagnostic tools suitable for rural settings.

Contribution

Muhammad Ali Hassan: Designed the research and developed the methodology.

Iqrar Hussan: Conducted experiments and collected data.

Umaira Sadiq Khan: Performed data analysis and interpretation.

Farhid Ahmad Jan: Wrote the manuscript, and Umaira Sadiq Khan reviewed and edited it. All authors approved the final manuscript.

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