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Effects of Bacteriospermia on Semen Parameters and their antibiotic sensitivity pattern among Infertile Males in Dutse, Jigawa State Nigeria.

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Abstract

Background: Infertility is a global public health issue that leads to psychological, social, and economic challenges, particularly affecting women. This study investigates the prevalence of abnormalities in seminal fluid and identifies common organisms along with their antibiotic sensitivities in male partners of infertile couples at RSFUTH in Jigawa State, Nigeria. **Methods:** This prospective cross-sectional study involved 389 infertile male subjects attending the andrology clinic at RSFUTH. Semen samples were analyzed over an 18-month period. **Results:** The findings showed that 68.9% of participants had primary infertility, while 31.1% had secondary infertility. Bacteriospermia was detected in 68.6% of cases, predominantly caused by *Staphylococcus aureus*. Significant antibiotic resistance patterns were observed: *S. aureus* exhibited resistance to penicillin (72%), ciprofloxacin (54%), and clindamycin (88%), but remained sensitive to moxifloxacin (79%) and gentamicin (80%). *Escherichia coli* demonstrated resistance to cefuroxime (52%) and levofloxacin (70%) but was sensitive to amikacin and gentamicin. Streptococcus species were resistant to gentamicin, while *Enterococcus faecalis* showed minimal resistance. **Conclusion:** This study revealed a high prevalence of bacteriospermia and substantial antibiotic resistance among isolates affecting male fertility. The findings underscore the importance of semen analysis in diagnosing and managing infertility. Future research with larger sample sizes and multi-center involvement is recommended to validate and expand upon these findings.

Keywords: : Semen, Bacteriospermia, S. aureus, Antimicrobial patterns, Infertility

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Introduction

Infertility is recognized as a significant global public health concern, impacting couples emotionally and socially, often leading to psychological stress, marital crises, and relationship disruptions, with women bearing a disproportionately heavy burden Diallo et al., 2024, Makwe et al., 2021, Umar et al., 2020. According to Makwe et al. (2021), infertility is defined as the inability of couples to conceive after one year of unprotected sexual intercourse.

Various factors contribute to infertility among both male and female partners, including hormonal imbalances, reproductive health disorders, infections, and abnormalities in semen quality Eini et al., 2021. Male infertility accounts for approximately 30% of all cases and is commonly associated with abnormalities in semen quantity—such as volume, concentration, and sperm count—and semen quality, including pH, morphology, and motility Eini et al., 2021; Makwe et al., 2021; Ngwu et al., 2022.

One of the major causes of semen abnormality is the detrimental effect of microbial pathogens, particularly bacteria in semen (bacteriospermia). Other contributing factors include stress, smoking, alcoholism, obesity, excessive physical activity, exposure to toxins, radiation, and elevated temperatures Boeri et al., 2020; Sarath & Brindha, 2024. Bacteriospermia remains a persistent challenge due to antimicrobial resistance driven by multiple factors, making it a significant contributor to male infertility Chang et al., 2023.

Microbial pathogens can negatively affect semen structure, volume, motility, morphology, and overall functionality by damaging sperm DNA, causing agglutination, altering morphology, and inducing inflammation that triggers the release of free radicals, ultimately leading to oxidative stress Chang et al., 2023.

The aim of this study was to evaluate the presence of bacterial pathogens in the semen of male partners of infertile couples and to analyze their antimicrobial sensitivity patterns. By investigating the relationship between these pathogens and semen abnormalities, the study seeks to contribute valuable insights that can inform clinical practice and guide effective management of male infertility.

Materials and Methods

Study Area

Jigawa State, located in northwestern Nigeria, has a population of 4,348,649 according to the 2006 National Population Census. The state consists of 27 local government areas and shares boundaries with Kano and Katsina States to the west, Bauchi State to the east, Yobe State to the northeast, and the Zinder Region of Niger Republic to the north. A substantial proportion of the population is engaged in self-directed work, primarily in agriculture Mansur et al., 2022; Yakudima et al., 2023.

Study Site

The study was conducted at the Rasheed Shekoni Federal University Teaching Hospital (RSFUTH), Dutse, a tertiary healthcare institution equipped with modern diagnostic and treatment facilities. RSFUTH provides services such as gynecological clinics, emergency care, and family planning clinics.

Study Design

A single-center prospective cross-sectional research design was used to evaluate bacterial pathogens present in semen samples collected from male partners of infertile couples attending RSFUTH.

Sampling Technique

A structured questionnaire was administered to obtain sociodemographic information. Semen samples were collected consecutively from consenting participants over an 18-month period (January 2023 to January 2025), yielding a total of 389 participants.

Semen Collection and Analysis

Participants were instructed to abstain from ejaculation for 3–5 days before sample collection. Semen samples were delivered to the laboratory within 30 minutes and maintained at 37°C. Following standard operating procedures, samples were examined microscopically and cultured under sterile conditions on blood, chocolate, and MacConkey agar plates. Cultures were incubated at 37°C for 24 hours and monitored for growth.

Bacterial isolates were identified using methods described by Gerhardt et al. (1994). Samples exhibiting pathogenic growth were subjected to antibiotic susceptibility testing using standard antibiotic discs. Each specimen was also cultured on nutrient agar at 37°C for 24–48 hours to isolate additional bacterial pathogens. Isolates were further subjected to biochemical tests for confirmation and sub-cultured to determine antimicrobial sensitivity patterns.

Data Analysis

Data were entered into Microsoft Excel and exported to SPSS version 26 for statistical analysis. Sociodemographic characteristics were summarized using frequencies and percentages.

Results

Variable	Frequency (%)
Infertility type	
Primary	268 (68.9)
Secondary	121 (31.1)
Age	
≤25	41 (10.5)
26–35	251 (64.5)
36–45	77 (19.8)
≥46	20 (5.2)
Sperm volume (ml)	
≤1.5	94 (24.2)
1.6–4.0	196 (50.4)
4.1–7.6	82 (21.1)
>7.6	17 (4.3)
Sperm counts	
<1 million	140 (35.9)
1–5 million	116 (29.8)
16–19 million	126 (32.5)
Azospermic	7 (1.8)
Motility	
Progressive	135 (34.8)
Non-progressive	36 (9.3)
Non-linear	21 (5.4)
Immotile	130 (33.5)
Head morphology	
Normal	100 (25.7)
Microcephalic	169 (43.4)
Macrocephalic	71 (18.3)
Pin head	39 (10.0)
Pyriform	8 (2.1)
Double head	2 (0.5)
Tail morphology	
Normal	115 (29.6)
Tailless	69 (17.7)
Short tail	62 (15.9)
Large tail	64 (16.5)
Double tail	59 (15.2)
Coiled tail	20 (5.1)

Table 1: Participant's characteristics and demographics

A total of 389 samples were examined, of which 267 (68.9%) were found to have primary infertility with a mean age of 30 years, while 121 (31.1%) had secondary infertility with a mean age of 33 years. Table 1 documents the sociodemographic characteristics of the study participants. Sperm volume was observed to be ≤ 1.5 ml in 94 (24.2%) individuals,

Isolates	Frequency (%)	Progressive (%)		Volume (ml)		Total sperm count (×10^6)	
		<32	≥32	<1.5	≥1.5	<39	≥39
S. aureus	90 (23.1)	61 (68%)	29 (32%)	20 (22%)	68 (78%)	72 (80%)	18 (20%)
E. coli	82 (21.1)	57 (70%)	25 (30%)	22 (27%)	60 (73%)	15 (18%)	67 (82%)
Streptococci	63 (16.2)	35 (56%)	28 (44%)	15 (23%)	48 (77%)	40 (63%)	23 (37%)
Klebsiella sp	62 (15.9)	30 (48%)	32 (52%)	17 (27%)	45 (73%)	49 (79%)	13 (21%)
E. faecalis	65 (16.7)	44 (68%)	21 (32%)	21 (32%)	44 (68%)	50 (77%)	15 (23%)
No growth	27 (6.9)	-	-	-	-	-	-

Table 2: Distribution of bacterial isolates from participants in respect to some semen parameters

Antibiotics	*S. aureus* (n=90)		*E. coli* (n=82)		Streptococci (n=63)		Klebsiella sp (n=62)		*E. faecalis* (n=65)	
	S	R	S	R	S	R	S	R	S	R
PEN	25 (28%)	65 (72%)	45 (55%)	37 (45%)	48 (76%)	15 (24%)	23 (37%)	39 (63%)	60 (92%)	05 (8%)
ERY	77 (86%)	13 (14%)	25 (30%)	57 (70%)	37 (59%)	26 (41%)	NT	NT	15 (23%)	50 (77%)
GEN	80 (89%)	10 (11%)	22 (27%)	60 (73%)	07 (11%)	56 (89%)	50 (81%)	12 (19%)	20 (31%)	45 (69%)
CIP	36 (40%)	54 (60%)	33 (40%)	49 (60%)	20 (32%)	43 (68%)	42 (68%)	20 (32%)	59 (91%)	06 (11%)
LEV	81 (90%)	09 (10%)	25 (30%)	57 (70%)	NT	NT	43 (69%)	19 (31%)	62 (95%)	03 (5%)
MOX	70 (78%)	20 (22%)	68 (83%)	14 (17%)	NT	NT	29 (47%)	33 (53%)	60 (92%)	05 (8%)
CLN	11 (12%)	79 (88%)	NT	NT	19 (30%)	44 (70%)	50 (81%)	12 (19%)	35 (54%)	30 (46%)
CEF	81 (90%)	09 (10%)	30 (37%)	52 (63%)	NT	NT	29 (47%)	33 (53%)	NT	NT
CEFR	45 (50%)	45 (50%)	20 (24%)	62 (76%)	NT	NT	35 (56%)	27 (44%)	NT	NT
AMI	79 (88%)	11 (12%)	80 (89%)	10 (11%)	NT	NT	15 (24%)	47 (76%)	45 (69%)	20 (31%)

Table 3: Antimicrobial sensitivity pattern of the isolates from male infertile subjects. **Notes:** S = Sensitive, R = Resistant, NT = Not tested. Percentages in parentheses. Abbreviations: PEN = Penicillin, ERY = Erythromycin, GEN = Gentamicin, CIP = Ciprofloxacin, LEV = Levofloxacin, MOX = Moxyclin, CLN = Clindamycin, CEF = Ceftazidime, CEFR = Cefuroxime, AMI = Amikacin.

1.6–4.0 ml in 196 (50.4%), 4.1–7.6 ml in 82 (21.1%), and ≥ 7.6 ml in 17 (4.3%).

The majority, 140 (35.9%), of participants had sperm counts of one million or less, 116 (29.8%) had counts ranging from 1–5 million, and 126 (32.3%) had counts of 16–19 million. Furthermore, 1.8% of participants were azoospermic. Analysis by age groups showed that individuals aged 26–35 years had the highest number of isolates, 251 (64.5%), while those aged ≤ 25 years had the lowest, 41 (10.5%).

Progressive motility was recorded in 135 (34.8%) participants, whereas 65.2% exhibited other motility abnormalities, including 33.5% immotile, 17% azoospermic, 9.3% non-progressive, and 5.4% zigzag movements. Normal sperm head morphology was found in 100 (25.7%) participants; however, several abnormal morphologies were also observed. Sperm with normal tails were observed in 115 (29.6%), while tailless, short tail, large tail, doubled tail, and coiled tail sperm were seen in 69 (17.7%), 62 (15.9%), 64 (16.5%), 59 (15.2%), and 20 (5.1%), respectively.

Table 2 presents the distribution of bacterial isolates against selected semen parameters. Overall, cultures yielded 90 (23.1%) *S. aureus*, 82 (21.1%) *E. coli*, 63 (16.2%) Streptococci, 62 (15.9%) Klebsiella sp., 65 (16.7%) *E. faecalis*, while 27 (6.9%) samples showed no growth. Evaluation of semen parameters by bacterial isolate showed that patients with non-progressive motility, decreased sperm volume, or counts ≥ 39 × 10^6 in *S. aureus* and *E. coli* were 61 (32%), 20 (22%), 18 (20%) and 57 (70%), 22 (27%), 67 (82%), respectively. Similarly, Streptococci, Klebsiella, and *E. faecalis* exhibited various deficiencies in semen parameters.

The antimicrobial sensitivity patterns showed that *S. aureus* displayed resistance rates of 72% to penicillin, 54% to ciprofloxacin, and 88% to clindamycin, while it was sensitive to amikacin (79%), gentamicin (80%), and levofloxacin (81%). *E. coli* exhibited resistance to cefuroxime (52%), levofloxacin (70%), ciprofloxacin (60%), and erythromycin (70%). Streptococcus strains were sensitive to penicillin (76%) and erythromycin (59%), but resistant to gentamicin and ciprofloxacin. Both Klebsiella sp. and *E. faecalis* showed varying activities and sensitivities to several antimicrobial agents (Table 3).

Discussion

This study aimed to determine abnormalities in seminal fluid and to identify the most common organisms present, along with their antibiotic sensitivities, in the seminal fluid of male partners of infertile couples. In sub-Saharan Africa, many men hesitate to undergo semen analysis during fertility assessments, often assuming infertility is primarily a female-related condition. Of the 389 semen samples analyzed, 267 individuals (68.9%) had primary infertility with a mean age of 30 years, while 121 individuals (31.1%) with secondary infertility had a mean age of 33 years. These findings align with those of Alemnji & Thomas, 1997, who reported a high proportion of secondary infertility, possibly due to increased exposure to infections.

Consistent with previous reports Al-Jebouri, 2015,Alekwe et al., 2013; Shash et al., 2023, this study identified pathogens in the semen of infertile males, with 68.6% showing bacteriospermia. *Staphylococcus aureus* was the most predominant isolate. Pathogens may impair semen quality by distorting morphology, reducing motility, and causing DNA fragmentation. This aligns with findings by Bhattacharya et al., 2024; Jendraszak et al., 2024, who reported that bacteriospermia affects several semen parameters.

Progressive sperm motility is essential for fertilization. Our findings revealed abnormal motility in patients infected with *S. aureus* and *E. coli*, and a significant number of cases of azoospermia and non-progressive motility associated with *Klebsiella* spp. and *Enterococcus faecalis*. Similar observations were made by Alekwe et al., 2013, who reported azoospermia in many bacteriospermic patients. However, Moretti et al., 2009 provided contrasting evidence, suggesting that some pathogens may not significantly impact semen motility.

This study also highlighted significant resistance of *S. aureus* to penicillin, ciprofloxacin, clindamycin, and ceftazidime. Penicillin resistance may be related to the production of penicillinase enzymes that degrade the beta-lactam ring. Our findings agree with Abebe et al., 2019; Al-Jebouri, 2015; Chang et al., 2023. Conversely, *S. aureus* showed sensitivity to moxifloxacin, cefuroxime, gentamicin, and amikacin, consistent with Hussein et al., 2018. In contrast, Solomon & Ganiyu, 2013 reported gentamicin resistance in *S. aureus*, possibly due to environmental differences, antimicrobial exposure, or variations in microbial genomes.

E. coli isolates demonstrated sensitivity to amikacin, moxifloxacin, and gentamicin, but high resistance to several other agents. These findings align with Abebe et al., 2019; Patil et al., 2013, who also reported high sensitivity of *E. coli* to amikacin and gentamicin. Comparatively, Joseph & Alexander, 2007; Olana et al., 2023 reported similar resistance patterns to ciprofloxacin, cefuroxime, and ceftazidime, likely due to plasmid-mediated resistance mechanisms.

Streptococcus species exhibited resistance to levofloxacin, clindamycin, and gentamicin, potentially linked to the presence of F1 protein in certain strains. These results agree with Solomon & Ganiyu, 2013, although Passàli et al., 2007 reported contrasting susceptibility due to differences in drug penetration and target site modification.

E. faecalis showed resistance to gentamicin and erythromycin while remaining sensitive to penicillin, ciprofloxacin, levofloxacin, moxifloxacin, and amikacin. These results align with Boccella et al., 2021. *Klebsiella* spp. demonstrated resistance to erythromycin and gentamicin but susceptibility to ciprofloxacin, cefuroxime, and clindamycin, consistent with Santella et al., 2024, who attributed resistance to impermeability, gene acquisition, and mutations.

Semen analysis remains a crucial diagnostic tool for identifying bacteriospermia and associated abnormalities. Although this study provides valuable insights, limitations include a relatively small sample size due to limited patient availability, and its single-center design may restrict generalizability.

Conclusion

This study highlights the significant prevalence of seminal fluid abnormalities and the frequent presence of bacterial pathogens in male partners of infertile couples. Bacteriospermia—particularly due to *S. aureus* and *E. coli*—was associated with impaired sperm quality and motility. Given the notable antimicrobial resistance patterns, clinicians should incorporate comprehensive semen analysis in evaluating male infertility and consider pathogen-targeted therapies.

Recommendations

To improve clinical practice, enhanced awareness and male participation in fertility evaluations are essential. Future studies should adopt larger, multicenter designs to validate these findings and deepen understanding of the relationship between pathogens and male infertility. Further exploration of antimicrobial resistance mechanisms is recommended to guide treatment decisions.

What is Known About the Topic

1. Bacteriospermia is well documented among male infertile subjects.
2. Microbial pathogens isolated from semen exhibit varying susceptibility and resistance to antibiotics.
3. Semen quality and quantity are critical determinants of infertility.

Author Contributions

YM, YAK, and SI conceptualized the study, collected specimens, and drafted the manuscript. AAH, RNA, and ATS recruited study participants. BM performed laboratory analyses. JM, RM, and MMH supervised the project.

Ethical Considerations

Ethical approval was obtained from the RSFUTH Ethics Committee. Informed consent was obtained from all participants prior to enrollment.

Conflict of Interest

The authors declare no conflict of interest.

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