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Comparison of the Oral Bacteria between Diabetic and Non-diabetic Dental Patients in Benghazi City

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ABSTRACT

Background: Recent research has emphasized the correlation between infectious microbes in Oral infections (dental caries, periodontal disease, and gingivitis) and diabetes; given that diabetic individuals may suffer from several health complications. So, our research aims to compare the oral bacteria between diabetic and nondiabetic dental patients with multiple antibiotics, which was investigated at Benghazi University, Faculty of Oral and Dental Medicine and Surgery. A comparative study of oral microbes in normal, non-diabetic, and diabetic patients with periodontal disease was performed. In this study, we've used a sample of a total of 250 periodontitis patients with a variant age spectrum, sub-grouped into 125 diabetic patients and 125 non-diabetic patients. Using conventional methods of microbial identification, we have been able to clearly label and characterize the isolated microbial content from collected samples. The results showed significantly higher ratios of microbial growth from samples collected from diabetic individuals with dental problems. Not to neglect, the observed results of average microbial growth of certain Gram-positive bacteria (such as Viridans Streptococci, and S. aureus) isolated from diabetic individuals was higher than nondiabetic. However, S. mutans has exhibited a much higher growth in platted samples isolated from non-diabetic individuals than diabetic. The significant microbial growth isolated from diabetic individuals {male was 66 (26.4%), and female was 52 (20.8%); in a total of 118 (47.2%). While non-diabetic individuals {male was 38 (15.2%), and female was 74 (29.6%)}; in a total of 112 (44.8%). Our study results conclude that certain gram-negative bacteria such as (Pseudomonas and E. coli) may show more abundance in diabetic patients with periodontitis than in non-diabetic individuals. Whereas, Klebsiella exhibited an opposite abundancy situation – found in our study more abundant in non-diabetic individuals than diabetic ones.

1. Introduction

The rectum, lower intestine, and upper intestine share ancestry with the mouth cavity. If a pathogen stays in the mouth cavity, it can spread quickly to other areas of the gut and associated organs. The mouth cavity is home to a variety of microorganisms that provide a special niche with a source of nutrients and water at a reasonable temperature (Griffen A.L., 2012). Saliva,

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subgingival to gingival crevicular fluid (GCF), and the rough and sticky surfaces of teeth are among the several microenvironments found in the oral cavity. Both culture-based and culture-independent molecular techniques have demonstrated that the complex oral microbiota comprises hundreds to thousands of different species (Arweiler N.B., 2016). On the surfaces of teeth, microorganisms create multispecies communities inside an extracellular polymeric matrix. The oral microbiota linked to diseases is different from the oral microbial community in healthy persons (Dabdoub S.M., 2016; Lamont R.J., 2018).

The majority of oral bacteria are not harmful, but opportunistic commensals guard against harmful microbes and maintain stable oral health conditions (Zbinden A., 2015). Dysbiosis and periodontal disorders (PD), including gingivitis and periodontitis, are caused by the conversion of normal oral bacterial species into pathogenic ones (Ali T, 2021).

Early in infancy, cariogenic bacteria infiltrate the dental biofilm, and in the right circumstances, they can eventually proliferate and cause illness (Scanlan C.A., 2018). The key bacterial species that were overrepresented in the caries-active community were Actinomycetes species, Streptococcus mutans, and Lactobacillus species. Saliva has a significant impact on microbial makeup, the decrease of dental plaque pH and cariogenic potential, and the sensitivity of tooth surfaces to dietary carbohydrates and plaque acidity. Compared to a healthy oral cavity, larger amounts of S. mutans and Streptococcus sorbinus have been isolated in these situations (Mohanty M., 2024).

Oral illnesses are often overlooked in public health policy, especially in poor nations, despite the fact that they continue to pose a serious global public health burden with substantial socioeconomic effects (Beaglehole R., 2014). Additionally, it is closely associated with non-communicable diseases (Jin L.J., 2016), including rheumatoid arthritis (Hendler A., 2010), osteoporosis, diabetes (Casarin R.C., 2013), atherosclerotic circulatory disease (Nguyen C.M., 2015), pulmonary disorders (Linden G.J., 2013), chronic renal disease, obesity, Alzheimer's disease, and pancreatic cancer (Jacob J.A., 2016). As a result, determining the makeup of the oral microbiota linked to health and illness has maintained attention (Ali T, 2021)

Hyperglycemia, a metabolic disorder caused by decreased insulin synthesis or secretion, is a hallmark of diabetes mellitus (Novotna M., 2015). Type I diabetes, type II diabetes, and type III diabetes associated with other illnesses and syndromes are the three forms of diabetes recognized by the World Health Organization (WHO) (Sadeghi R., 2017).

According to the most recent statement issued by "The International Diabetes Federation" (IDF), there are around 537 million persons worldwide who suffer from diabetes mellitus (DM), making it a significant global burden (Agarwal J., 2024). By 2040, it is anticipated that 642 million people globally will have diabetes (Ali T, 2021). In addition to knowing that diabetes is linked to certain dental health issues, such as periodontitis, xerostomia, and candidal infections, dentists have long understood the significance of identifying diabetes in their patients (Cicmil S., 2018; Mohamed H. H., 2024).

According to reports, the sixth most frequent complication among individuals with diabetes mellitus is periodontal disease (Grover H.S., 2013; Rafatjou R., 2016). But according to some academics, there isn't any such elevated danger. According to certain new research, diabetes is a risk factor for periodontal disease but not a direct cause of it. Gingivitis and periodontitis cannot be attributed to diabetes; instead, the metabolic abnormalities caused by the disease might lead to systemic issues that reduce resistance to infections (Sadeghi R., 2017).

Consequently, there is an impact on the development, start, and progression of periodontal disorders (Rafatjou R., 2016). Numerous research has examined the connection between dental and periodontal health and diabetes mellitus type I, with varying degrees of agreement. According to certain research, people with diabetes mellitus are more likely than people without the condition to have caries periodontal diseases (Rai K., 2011; Arheiam A., 2014; Ismail A.F., 2015) and plaque indices (Gujjar K.R., 2011;

Ismail A.F., 2015) Furthermore, even though their plaque index is equal, children with diabetes had more severe gingivitis than children without the disease. Additionally, while having equal subgingival biofilm, poorly managed diabetic individuals appear to have a threefold increased risk of developing chronic periodontitis in comparison to healthy people (Sadeghi R., 2017).

So, our aim is to compare the oral bacteria between diabetic and nondiabetic dental patients with multiple antibiotics, which was investigated at Benghazi University, Faculty of Oral and Dental Medicine and Surgery.

2. Material and Method

The main purpose of this study is to contribute to improving public dental health, focusing on patients with periodontitis. Due to the wide range of health complications diabetic individuals may encounter, we have included a comparison between diabetic and non-diabetic individuals with periodontitis.

1. Enrolment of diabetic and non-diabetic patients with periodontitis.

Patients were recruited from the Faculty of Dentistry, University of Benghazi Teaching Hospital in Benghazi. is the main public referral hospital in Benghazi city, providing dental services for the entire country with a daily average of 150 patients visiting the center. All the enrolled participants were included in this study 250 in total within a month period. Participants were grouped according to diabetic status: 125 patients with T2D and 125 without the disease. The two groups were individually matched according to age and gender, with periodontitis.

The study participants were enrolled between January and August 2020, it took longer time due to COVID–19 restrictions. One hundred and twenty-five type 2 diabetes (T2D); they were 62 men and 63 women. The mean age for T2D patients was 52.59 ± 10.50 years (range 24 to 70 years). Diabetes was diagnosed by specialist physicians at the center according to the criteria of the American Diabetes Association. Those selected patients were also experiencing periodontal treatment during the last 6 months and no pregnancy or lactation. Bearing in mind that, the T2D patients underwent an HbA1c test by boronated affinity chromatography (153) (wellcontrolled: HbA1c ≤ 8% and poorly controlled: HbA1c > 8%, 8% = 64 mmol/mol) to determine the level of glycemic control.

The eligibility criteria for enrolment were:

- Diagnosed with T2D more than one year ago.
- At least 10 remaining natural teeth.
- No medication with antibiotics or steroidal and/or non-steroidal anti-inflammatory agents over the past 3 weeks.
- No immunosuppressive chemotherapy, no current acute illness, no professional.
- Subjects without diabetes were asked about signs and symptoms of diabetes and if suspected, they were referred for confirmation.

One hundred and twenty-five subjects without diabetes. The mean age of participants without diabetes was 52.36 ± 10.50 years (range 24 to 70 years). With the exception of a diagnosis of diabetes, the same selection criteria as above were applied to the recruitment of participants without diabetes. Subjects without diabetes were asked about signs and symptoms of diabetes and if suspected, they were referred for confirmation.

Experimental work and analysis:

(a) Sample collection: 250 Swab specimens were taken from the oral cavity of diabetic and non-diabetic patients with gingivitis to be cultured on various media cultures for further analysis later.

(b) Preparation of various selective and differential media cultures: such as MacConkey agar, Chocolate agar, Blood agar base, Eosin methylene blue (EMB) agar, Mueller Hinton agar, and Nutrient agar.

(c) Samples culturing and incubation: The conventional road to identify the microbial content of collected samples was taken. We have platted them the previous freshly prepared differential and selective medium, separating isolated samples from diabetic and nondiabetic individuals. Then, incubating 37oC under aerobic conditions for 24- 48 hours, after which plates were observed for microbial growth.

(d) Identification of bacterium exhibited significant growth: Routine laboratory techniques were carried out including Gram staining, Biochemical identification tests for gram-negative bacteria (Oxidase Test, Urease test, and Indole Test Using Tryptone Water), and Biochemical identification tests for gram-positive bacteria (Coagulase Test, Catalase Test, DNase test, Optochin), Antibiotic sensitivity tests, and Virulence Factors Determination.

(e) Microscopic examination of platted microbial growth and colonial morphology characterization of grown bacteria: Our study has had an interesting variety of microbial such as Viridans streptococci, Staphylococcus aureus, Klebsiella, E. coli, Pseudomonas, and Streptococcus mutans.

(f) Testing Antimicrobial Susceptibility by modified Kirby-Bauer disc diffusion method: Where all bacterial strains isolated were subjected to antimicrobial susceptibility test by using disc diffusion methods and the Phoenix technique. According to the protocol of the infection control lab, the following antibiotics were used:

1. Antimicrobials tested for Gram-positive bacteria.
•β -Lactams (Amoxicillin, Cefotaxime, Oxacilin and Imipenem)
•Aminoglycosides (Gentamicin).
•Tetracyclines (Tetracycline).
•Others (Vancomycin, sulfamethoxazole, Azithromycin, Amikacin).
2. Antimicrobials tested for Gram-negative bacteria.
•Cephalosporin (ceftazidime)
•Quinolones (Ciprofloxacin).
•β-Lactams (Amoxicillin, Ceftazidime, Cefotaxime, Imipenem).
•Aminoglycosides (Amikacin, Gentamicin,).
•Tetracyclines (Tetracycline).
•Others (sulfamethoxazole, Clarithromycin, Cefixime, Aztreonam).

Sensitivity test:

The antimicrobial agents listed below include the disc content of antibiotics.

Table 1 List of antimicrobial agents used

Antibiotic	Symbol	Disc potency (µg)	Inhibition zone diameter (mm)		
			R	I	S
Optachin	OP	5	≤ 14	15 – 16	≥17
Gentamycin	CN	30	≤12	13 – 14	≥15
Cefixime	CFM	5	≤ 17	18 – 20	≥21
Aztreonam	ATM	30	≤ 17	18 – 19	≥19
Azithromycin	AZM	15	≤ 18	19 – 20	≥21
Ceftriaxone	CRO	30	≤ 13	14 – 20	≥21
Augmentin	AMC	30	≤ 13	14 – 17	≥18
Ampicillin/Sulbactam	SAM	20	≤ 11	12 – 14	≥15
Ampicillin	AMP	10	≤ 11	12 – 13	≥14
Cephalothin	KF	30	≤ 14	15 – 17	≥18
Amikacin	AK	30	≤ 14	15 – 16	≥17
Ceftriaxone	CRO	30	≤ 13	14 – 20	≥21
Imipenem	IMP	10	≤ 13	14 – 15	≥16
Ceftazidime	CAZ	30	≤ 14	15 – 17	≥18
Ciprofloxacin	CIP	5	≤ 15	16 – 20	≥21
Leucine	LEU	15	≤ 10	10 - 11	≥12
Cefotaxime	CTX	30	≤ 14	15 – 22	≥23
Sulfamethoxazole trimethoprim	SXT	1.25+23.75	≤ 10	11 - 15	≥16
Oxacillin	OX	5	≤ 19	19 - 20	≥21
Vancomcin	VA	30	≤ 12	13-14	≥15
Tetracycline	TE	30	≤ 14	15-18	≥19
Clindamycin	CL	2	≤ 14	15 – 20	≥21
Cefepime	CFM	30	≤ 14	15 – 17	≥18

The bacterial isolate was designated sensitive (S) intermediate (I) or resistance (R) using the Kirby Bauer interpretative chart.

3. Results

In this study, we've used a sample of a total of 250 periodontitis patients with a variant age spectrum, sub-grouped into 125 diabetic patients and 125 non-diabetic patients. 230 of the plated samples exhibited significant microbial growth. Meanwhile; there were 20 isolates (8%) that didn't exhibit any sign of microbial growth.

Each step of this study is sub-sequential. Therefore, it's crucial to illustrate each one at a time.

The initial results of growing samples taken from patients illustrated in Table 2:

Table 2 Initial results of growing samples taken from patients

Growth results	Number	percentage
Samples with significant growth	230	92%
Samples without any growth	20	8%
Total	250	100%

There were 6 types of bacteria mainly isolated: which are Viridans Streptococci 32 (12.8%) isolates, Staphylococcus aureus 41 (16.4%) isolates, Klebsiella 25 (10%) isolates, Streptococcus mutans 87 (34.8%) isolates, Pseudomonas 9 (3.6%) isolates, Escherichia coli 12(4.8%), and Diplococcus 10 (4%). In addition to the noticeable growth of Candida spp. (yeast) in some samples at the count of 14 (5.6%) isolates.

Samples with significant growth showed that:

•Male diabetic patients were a total of66 (26.4%); 11 of Viridans Streptococci, 23 Staphylococcus aureus, 5 Klebsiella, 21 Streptococcus mutans, 2 Pseudomonas, 4 Escherichia coli.

•Male non-diabetic patients were a total of38 (15.2%); 3 Viridans Streptococci, 1 Staphylococcus aureus, 2 Klebsiella, 20 Streptococcus mutans, 3 Pseudomonas, 4 Escherichia coli, 5 Candida spp.

•Female diabetic patients were a total of52 (20.8%); 16 Viridans Streptococci, 12 Staphylococcus aureus, 11 Klebsiella, 9 Streptococcus mutans, 2 Pseudomonas, 2 Escherichia coli, 0 Candida spp.

•Female non-diabetic patients were a total of 74 (29.6%); 2Viridans Streptococci, 5 Staphylococcus aureus, 6 Klebsiella, 37 Streptococcus mutans, 2 Pseudomonas, 2 Escherichia coli, 13 Candida spp., and 7 showed growth of Diplococcus.

The following Table 3 shows the complete data of microbial growth of this study:

Table 3 The complete data of microbial growth in our research

Isolated microbes	**No.**	**(%)**	**Male diabetic**	**(%)**	**Male non-diabetic**	**(%)**	**Female diabetic**	**(%)**	**Female non-diabetic**	**(%)**
Viridans Streptococci	32	12.8	11	4.4	3	1.2	16	6.4	2	0.8
Staphylococcus aureus	41	16.4	23	9.2	1	0.4	12	4.8	5	2
Klebsiella	24	9.6	5	2	2	0.8	11	4.4	6	2.4
Streptococcus mutans	87	34.8	21	8.4	20	8	9	3.6	37	14.8
Pseudomonas	9	3.6	2	0.8	3	1.2	2	0.8	2	0.8
Escherichia coli	12	4.8	4	1.6	4	1.6	2	0.8	2	0.8
Candida spp	18	5.6	0	0	5	2	0	0	13	5.2
Diplococcus	7	2.5	--	--	--	--	--	--	7	2.8
Total	230	92	66	28	38	15.2	52	20.8	74	29.6

From the previous figures, we can conclude the following ratios of isolated microbes from patients at different age ranges:

Table 4 Ratios of isolated microbes from patients at different age range

Isolated microbes	Age range (20- 40)	(%)	Age range (41- 86)	(%)
Viridans Streptococci	8	20.5	31	79.5
Staphylococcus aureus	13	31.7	28	68.3
Klebsiella	7	28	18	72
Streptococcus mutans	55	68.75	25	31.25
Pseudomonas	5	55.56	4	44.45
Escherichia coli	3	25	9	75
Candida spp	4	40	10	60
Diplococcus	3	30	7	70

The previous data can be visualized as follows in figure 1:

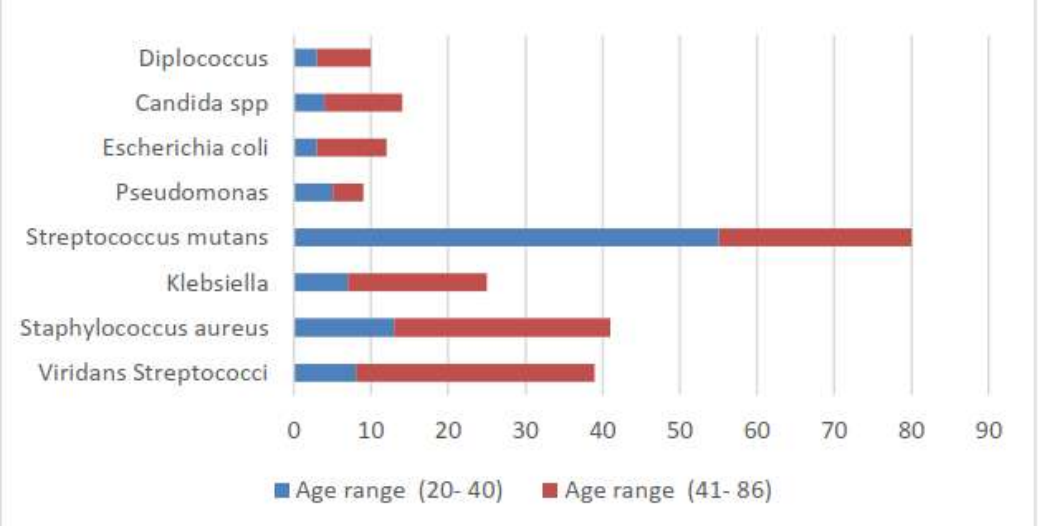

Figure 1 Ratios of isolated microbes from patients at different age range

The following table (5), figure 2 illustrates the numbers of Gram-positive isolated microbes from patients (with/ without diabetes) that exhibited sensitivity toward the used antibiotics:

Note: We tried to test a wide range of market antibiotics against different tested samples, not all mentioned antibiotics were tested against all samples. In case of patients with diabetes, there were more abundancy of

the resulted gram-positive bacteria compared to patients without diabetes; Moreover, the sensitivity of those gram-positive bacteria towards the used antibiotics was higher in non-diabetic patient than in diabetic patients.

Table 5 Numbers of Gram-positive isolated microbes from patients (with/ without diabetes) that exhibited sensitivity towards the used antibiotics.

	Viridans Streptococci (Male diabetic)	Viridans Streptococci (Female diabetic)	Viridans Streptococci (Male non-diabetic)	Viridans Streptococci (Female non-diabetic)	Staphylococcus aureus (Male diabetic)	Staphylococcus aureus (Female diabetic)	Staphylococcus aureus (male non-diabetic)	Staphylococcus aureus (Female non-diabetic)	Streptococcus mutans (Male diabetic)	Streptococcus mutans (Female diabetic)	Streptococcus mutans (Male non-diabetic)	Streptococcus mutans (Female non-diabetic)
Optachin	2%	3%	3%	4%	0.80%	1.50%	1.20%	2%	2%	2.70%	3%	4.00%
Z	60%	73%	61%	75%	44%	30%	45%	33%	73%	80%	76%	84%
CN	73%	44%	74%	47%	65%	50%	67%	53%	83%	68%	86%	69%
CFM	67%	52%	68%	55%	77%	49%	78%	52%	78%	57%	80%	60%
ATM	65%	48%	66%	49%	70%	53%	72%	54%	80%	71%	82%	77%
AZITH	52%	54%	55%	57%	43%	47%	44%	49%	67%	72%	68%	74%
Cephalox	37%	33%	39%	37%	46%	42%	48%	43%	56%	49%	58%	53%
AK	31%	29%	36%	31%	33%	25%	35%	27%	30%	35%	35%	38%
Ceftriaxo	87%	76%	90%	83%	84%	72%	86%	75%	88%	79%	90%	89%
IPM	89%	68%	92%	73%	86%	72%	87%	73%	90%	78%	92%	85%
CAZ	80%	61%	84%	65%	88%	63%	90%	64%	89%	64%	93%	68%
cip	90%	65%	93%	67%	86%	56%	87%	59%	93%	67%	95%	70%
LEU	78%	60%	81%	63%	59%	32%	62%	35%	65%	15%	70%	20%
CRO	73%	77%	77%	73%	67%	86%	65%	87%	88%	78%	89%	79%
AMC	65%	76%	64%	78%	78%	65%	82%	69%	77%	79%	80%	94%
CTX	50%	70%	55%	76%	58%	64%	63%	67%	75%	78%	77%	88%
SXT	68%	67%	72%	75%	65%	72%	70%	75%	57%	65%	60%	67%
OX	20%	30%	26%	34%	43%	40%	47%	45%	50%	45%	55%	49%
TE	57%	49%	66%	52%	47%	54%	48%	55%	64%	67%	65%	69%
VA	47%	66%	48%	67%	56%	53%	58%	54%	76%	74%	78%	76%
ON	57%	48%	57%	48%	65%	56%	67%	59%	87%	89%	89%	96%
OP	64%	62%	64%	62%	56%	63%	59%	67%	69%	78%	73%	80%
CFM	32%	58%	36%	59%	87%	58%	90%	62%	76%	56%	79%	57%
CL	62%	54%	64%	58%	43%	45%	47%	49%	37%	54%	47%	56%
AZM	54%	64%	58%	68%	76%	79%	81%	87%	76%	89%	79%	92%

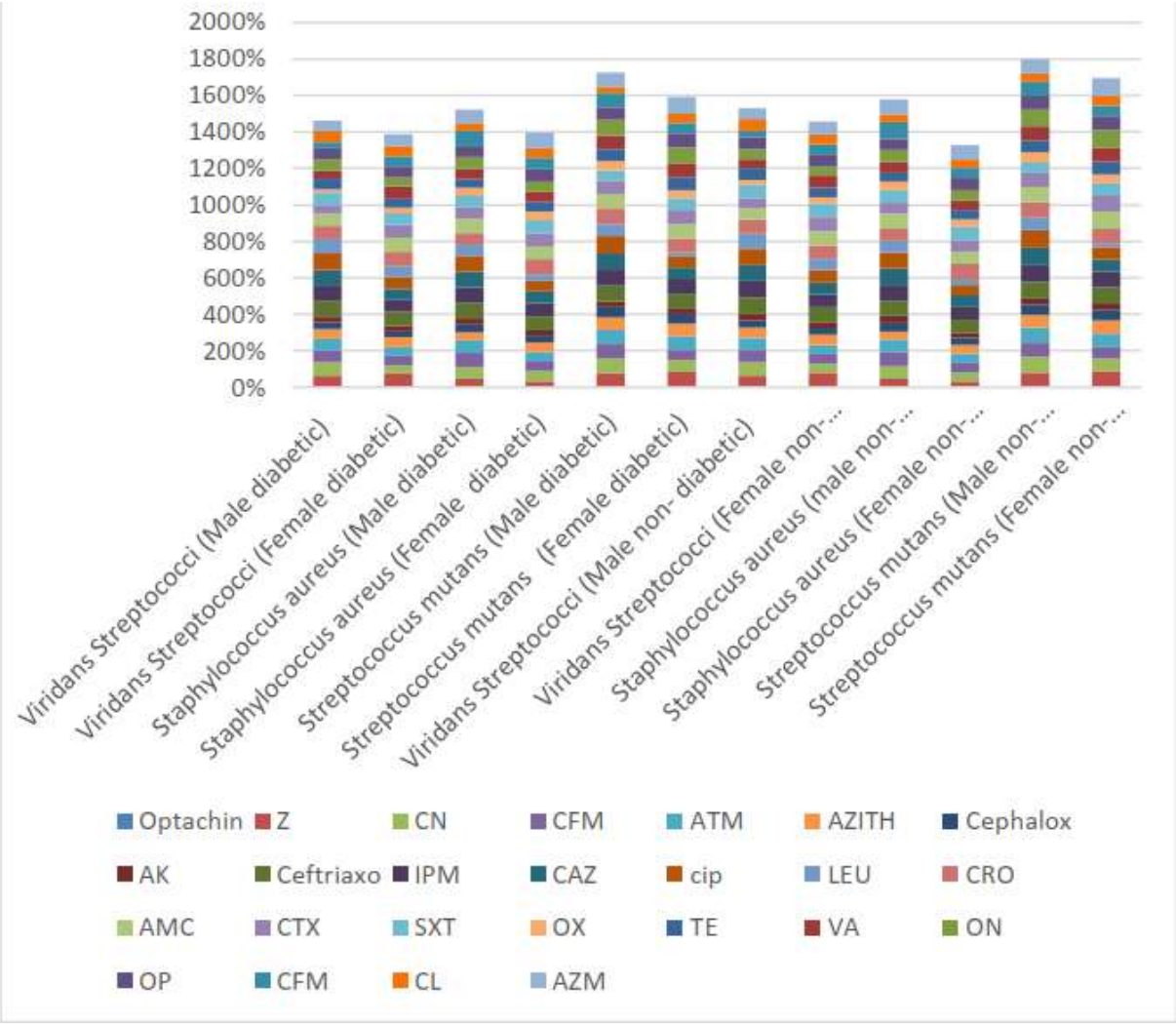

Figure 2 Numbers of Gram-positive isolated microbes from patients (with/ without diabetes) that exhibited sensitivity towards the used antibiotics.

The following table (6), figure 3 illustrates the numbers of Gram-negative isolated microbes from patients (with/ without diabetes) that exhibited sensitivity toward the used antibiotics:

Table 6 The numbers of Gram-negative isolated microbes from patients (with/ without diabetes) that exhibited sensitivity towards the used antibiotics

	Klebsiella (Male diabetic)	Klebsiella (Female diabetic)	E. coli (Male diabetic)	E. coli (Female diabetic)	Pseudomonas (Male diabetic)	Pseudomonas (Female diabetic)	Klebsiella (Male non-diabetic)	Klebsiella (Female non-diabetic)	E. coli (Male non-diabetic)	E. coli (Female non-diabetic)	Pseudomonas (Male non-diabetic)	Pseudomonas (Female non-diabetic)
Optachin	39%	33%	47.00%	35.00%	21%	22.00%	46%	50%	25.00%	30.00%	10%	7%
Z	23%	28%	44%	30%	33%	40%	43%	45%	45%	33%	9%	11%
CN	32%	29%	35%	32%	43%	38%	34%	42%	47%	53%	13%	12%
CFM	27%	32%	40%	39%	38%	37%	38%	41%	38%	52%	17%	20%
ATM	23%	20%	37%	33%	50%	41%	66%	49%	42%	44%	8%	14%
AZITH	22%	24%	36%	37%	47%	60%	45%	35%	44%	49%	15%	9%
Cephalox	30%	33%	46%	42%	56%	49%	39%	37%	48%	43%	14%	18%
AK	32%	29%	33%	47%	30%	35%	36%	31%	35%	27%	24%	27%
Ceftriaxo	17%	22%	44%	52%	58%	69%	40%	43%	33%	25%	26%	25%
IPM	34%	29%	51%	43%	60%	58%	32%	33%	27%	43%	30%	29%
CAZ	30%	32%	48%	39%	63%	64%	44%	45%	40%	34%	23%	28%
cip	20%	22%	46%	53%	53%	47%	33%	37%	37%	29%	34%	31%
LEU	18%	23%	49%	32%	65%	15%	41%	40%	32%	35%	40%	20%
CRO	24%	27%	55%	46%	48%	56%	47%	38%	35%	46%	39%	35%
AMC	36%	42%	48%	50%	71%	54%	34%	38%	48%	40%	30%	24%
CTX	31%	39%	56%	54%	75%	78%	25%	36%	43%	36%	27%	28%
SXT	41%	37%	65%	61%	57%	65%	42%	45%	47%	50%	30%	27%
OX	22%	30%	53%	57%	50%	45%	26%	34%	47%	45%	45%	39%
TE	25%	41%	47%	54%	64%	67%	46%	52%	48%	55%	37%	39%
VA	43%	36%	56%	53%	76%	74%	48%	47%	38%	44%	38%	26%
ON	32%	42%	65%	56%	87%	89%	51%	48%	51%	49%	29%	35%
OP	10%	14%	56%	63%	69%	78%	48%	42%	39%	47%	43%	40%
CFM	26%	29%	57%	55%	76%	56%	36%	49%	40%	36%	42%	37%
CL	25%	31%	63%	57%	37%	54%	44%	28%	47%	49%	37%	36%
AZM	40%	45%	61%	59%	76%	89%	26%	38%	31%	27%	29%	42%

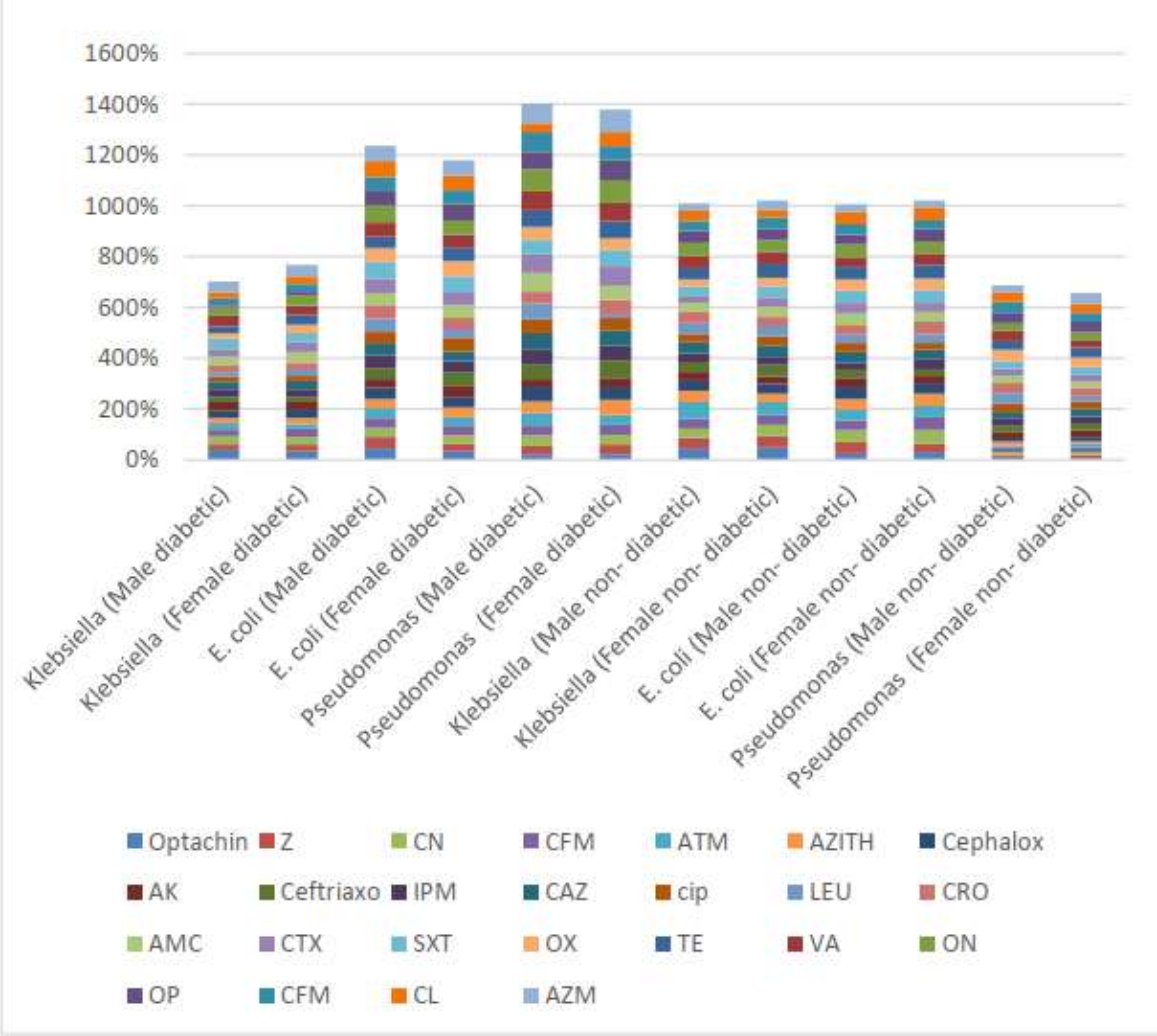

Figure 3 The numbers of Gram-negative isolated microbes from patients (with/ without diabetes) that exhibited sensitivity towards the used antibiotics

Statistical point of view for our resulted data; we found that the average appearance of Viridans Streptococci, Staphylococcus aureus, Klebsiella, Streptococcus mutans, Pseudomonas, Escherichia coli, Candida spp., and Diplococcus including the sample that didn't show significant growth in both diabetic and non- diabetic patients separately.

Table 7 Statistical analysis for the average appearance of different bacterial isolates

	Viridans Streptococci	*S. aureus*	*Klebsiella*	*S. mutans*	*Pseudomonas*	*E. coli*	*Candida spp*	*No Growth*	*Diplococcus*
Male diabetic	11	23	5	21	1	4	0	2	0
Male non- diabetic	3	1	2	20	3	4	5	2	0
Female diabetic	16	12	11	9	1	2	0	7	0
Female non- diabetic	2	5	6	37	2	2	13	9	7
Total	32	41	24	87	9	12	18	20	7
average diabetic	13.5	17.5	8	15	1	2.5	0	4.5	0
average non-diabetic	2.5	3	4	36	2.5	3	9	5.5	2.5
standard deviation of diabetic	3.5	7.78	4.24	8.49	0	0.71	0	3.54	0
variance of diabetic	12.5	60.5	18	72	0	0.5	0	12.5	0
standard deviation of non- diabetic	0.71	2.83	2.83	22.63	0.71	1.41	5.66	4.95	3.5
variance of non-diabetic	0.5	8	8	512	0.5	2	32	24.5	12.5

4. Discussion

Hereby we can describe our outcomes of this study, that samples with significant microbial growth isolated from non-diabetic individuals {male was 38 (15.2%), and female was 74 (29.6%)}; in a total of 112 (44.8%). In the samples with significant microbial growth isolated from diabetic individuals {males were 66 (26.4%), and females were 52 (20.8%); in total 118 (47.2%).

Indicating significantly higher ratios of microbial growth from samples collected from diabetic individuals with dental problems. Not to neglect, we have observed in our study that on average higher microbial growth of certain Gram-positive bacteria (such as Viridans Streptococci, and S. aureus) isolated from diabetic individuals than nondiabetic. However, S. mutans has exhibited a much higher growth in platted samples isolated from non-diabetic individuals than diabetic.

Meanwhile, isolated Gram-negative bacteria have shown slight differences in growth, As in E. Coli which has exhibited growth in an average of 2.5 in diabetic, and 3 in nondiabetic. Similarly, Pseudomonas has exhibited an average of 1 in diabetics and 2.5 in non-diabetics. With an outstanding growth of Candida spp., as well as, Diplococcus in platted samples isolated from non-diabetic individuals.

We have found that our results highly align with a study conducted by Adam et al., (2015), which highlights the assessment of the conjunctival bacterial flora in diabetic patients and nondiabetic people; presenting that 38.5% of diabetic patients and 34.9% of nondiabetic controls were bacterial isolations. Staphylococcus aureus was isolated in 30% of cases in the diabetic patient group, whereas; 20% tested positive for Escherichia coli, 10% for coagulase-negative Staphylococcus, 10% for Klebsiella pneumoniae and 30% for several bacteria. Also, 53.3% of non-diabetic patients were positive for Staphylococcus aureus while coagulase-negative Staphylococcus was isolated in 26.7%, Klebsiella pneumonia in 6.7% and many other bacteria in 13.3% of patients. Concluding that, gram-negative bacteria are communal in the conjunctival flora of diabetic patients more than non-diabetic.

Also, Bissong, (2014) in his comparison of oral microbial flora specifically aerobic oral microbial flora in diabetics and non-diabetics found that the most prevalent microbes were Streptococcus sp (99.6 %), Candidaalbicans (17.0 %), Serratia Spp (7.2 %), other Candida spp (6.8 %), Coagulase negative Staphylococci (CNS) (6.4 %) and

Klebsiella spp (5.7 %). Candida sp was more prevalent in diabetic patients than non-diabetics. Gram-negative aerobic bacteria were significantly isolated from cases of dental caries. Concluding that, the oral microbiological profile of diabetic patients was different from those of non-diabetics and aerobic Gram-negative bacteria may play an important role in dental diseases in diabetic patients.

Moreover, a study was conducted by Sultan, et al., (2013), to determine the occurrence of Candida spp. in periodontitis patients with type 2 diabetes mellitus. They found that the total occurrence of Candida in diabetic patients with periodontitis observed was 52% of 42 diabetic patients with periodontitis.

Another study conducted by A. Al-Abdul and K. Hussein, (2017) has shown that Staphylococcus spp. was more common, as represented by 13(29.5%) in the diabetic group and 27(50.9%) in the non-diabetic group, followed by Enterobacteriaceae that represented (27.3%), (13.2%) in diabetic and nondiabetic patients respectively. Whereas, Streptococcus spp represented 8(18.2%) in diabetics and 4(7.5%) in nondiabetic, Leuconostoc spp represented 4(9.1%) in diabetics and 6(11.3%) in nondiabetic.

Kumar, et. al., (2012) conducted a study that proved that even though periodontal disease is caused by microbes. However, the host response can be altered by a multitude of factors like systemic disease, senility, nutritional, hormonal, and genetic factors. Diabetes is found to be one major disease that increases the severity of periodontitis.

Kudiyirickal and Pappachan, (2015) tried to explain the pathogenic interrelationship between periodontal disease and diabetes. Explaining that; due to altered immune cell function in diabetic patients, an increase in the production of proinflammatory cytokines which promotes the destruction of periodontal tissues, and decreased elimination of periodontal pathogens was induced.

Later, Shim and Babu, (2014) went into more detail to explain the condition of diabetic hyperglycemia that promotes monocyte secretion of inflammatory cytokines and bacterial adherence to epithelial cells due to producing glycated albumin. Concluding that, glycated albumin stimulates cultured monocytic cells to secrete inflammatory cytokines. This stimulation was greater when cells were incubated with lipopolysaccharide along with glycated albumin. Which may contribute to the severity of periodontal disease in diabetic subjects.

Furthermore, Hsaine S., (2018) reasoned that poorly controlled diabetes causes metabolic dysregulation that can build the seriousness of the periodontal disease. where they discovered There was more noteworthy bacterial diversity in diabetic patients when contrasted with non-diabetic patients. Periodontal pathogens were disconnected from both diabetic and non-diabetic populaces; notwithstanding, certain microbes, for example, Streptococcusacidominimus, Enterobacter cloacae, Klebsiellaoxytoca, and Pseudomonasaeruginosa were available just in diabetics, with a lot higher rate in those with inadequately controlled diabetes.

Therefore, we can depend on this explanation for our intriguing antimicrobial susceptibility test results, which indicated the clear resistance of the isolated samples from diabetic patients toward all the antibiotics used in our study.

5. Conclusion

This study is designed to compare the microbial content of oral cavities isolated from diabetic and non-diabetic patients with periodontitis. From the current study, it can be concluded that diabetics suffer from oral health problems more than non-diabetics. This study found that diabetics do just that Oral complications and therefore should be encouraged to consult dentists regularly to ensure that the oral cavity is as healthy as possible. This will enable them to comply with dietary recommendations for diabetics.

Analysis of collected samples showed that certain gram-negative bacteria such as (Pseudomonas and E. coli) may show more abundance in diabetic patients with periodontitis than in non-diabetic individuals. Whereas, Klebsiella exhibited an opposite abundancy situation – found in our study more abundant in non-diabetic individuals than diabetic ones. Meanwhile; certain gram-positive

bacteria such as (Streptococcus mutans) in diabetic patients with periodontitis were most abundant compared to Viridans Streptococci, and Staphylococcus aureus.

Furthermore, the antimicrobial susceptibility tests showed that isolated microorganisms from diabetic individuals may exhibit higher resistance to the commonly used antibiotics than non-diabetic individuals. Intervention strategies are needed for diabetics to help patients maintain blood sugar levels as this has an effect on the development of diabetes complications and thus Quality of life in general. In addition to intensive treatment for gum disease in diabetic patients, it may reduce the harmful effects of the inflammatory environment Control of diabetes, and the patient's cardiovascular health.

6. References

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