Vol. 17(11), pp. 331-337, November, 2023
DOI: 10.5897/JMPR2023.7321
Article Number: 95E14DF71557
ISSN 1996-0875

http://www.academicjournals.org/JMPR

ACADEMIC JOURNALS
expand your knowledge

Journal of Medicinal Plants Research

Full Length Research Paper

Phytochemicals properties of *Carica papaya* Linn seeds' essential oil and their antifungal and antibacterial activities

OUEDRAOGO Assétou[1,2], NIKIEMA Philippe Augustin[1]*, YAMEOGO Gérard Josias[1,3], SOURABIE Pane Bernadette[2], BASSAVE Belinda Ramata Hafouo[2], KONATE Soumaïla[2], NIKIEMA Marguerite Edith[1], NIKIEMA Oueogo[2], GOUMBRI Wendinmi Bertrand Florent[2] and BARRO Nicolas[1]

[1]Laboratoire de Biologie moléculaire, d'Epidémiologie et de Surveillance des Bactéries Et Virus Transmissibles par les Aliments (LaBESTA), Université Joseph KI-ZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso.
[2]Agence Nationale pour la Sécurité Sanitaire de l'Environnement, de l'Alimentation, du Travail et des produits de santé (ANSSEAT), Burkina Faso.
[4]Laboratoire du Développement du Médicament (LADME), Centre de Formation de Recherche et d'Expertises en Sciences du Médicament (CEA-CFOREM), Université Joseph KI-ZERBO, Ouagadougou 03 BP 7021, Burkina Faso

Received 25 July, 2023; Accepted 18 September, 2023

Carica papaya **seeds have been used as traditional medicine. This study aims to determine the phytochemicals of papaya seeds essential oils their antimicrobial properties. Polyphenolic content and antioxidant properties were determined with standard methods. GC-MS was used to analyze chemical compounds. Antimicrobial properties were performed using agar diffusion method. MICs, MBCs and MFCs were established based on broth dilution methods. The results shown an average content of polyphenol compounds and antioxidant activity of 95.49 µg GAE /100 mL and 5569.06 µg AEAC/100 mL respectively. A total of 11 phytochemical compounds were identified and, Isothiocyanatomethyl (97.27%), Benzyl isocyanate (0.55%), Benzyl nitrile (0.43%)11,13-Tetradecadien-1-ol (0.28%) and Thioura, N, N'-bis (phenylmethyl) (0.26%) are major compounds. The essential oils were effective against *Candida albicans*, *Candida* spp, *Escherichia coli*, *Salmonella* spp, *Shigella* spp, *Staphylococcus aureus* and standards strains such as *C. albicans* 10231 *S. aureus* ATCC 08275, *Salmonella typhimurium* ATCC 14028, *E. coli* ATCC 25922 and *E. coli* ATCC 8739. Fungi MICs were from 0.16 to 0.38.10^{-2} mg.mL while MFCs were between 0.31 and 0.78 10^{-2} mg.mL. Bacteria MICs are from 0.09 to 6.25 while MBCs varied from 0.2 to 12.5 mg.mL. These essentials oils are possible improved traditional medicine against enterobacteria.**

Key words: Essential oils, *Carica papaya*, Phytochemical properties, antioxidant, antifungal and antibacterial activities.

INTRODUCTION

Carica papaya Linn is an herbaceous and laticiferous plant cultivated throughout the tropics for food and as a cash crop. The plant belongs to the Caricaceae family and can reach up to 10 m high (Lim, 2012). The precise center of origin for this species is difficult to define as no direct archeological evidence has been found up to date

(Yogiraj et al., 2014). It originated from natural hybridization (Lim, 2012). *C. papaya* is a tropical plant, spread to India, Oceania, Africa, and nowadays it is widely distributed throughout the tropics and warmer subtropical areas of the world (Hillocks, et al., 2002; Lim, 2012; Yogiraj et al., 2014; Yogiraj et al., 2014; Chávez-Pesqueira and Núñez-Farfán, 2017). The whole plant of *C. papaya* is world widely used for both food and medicine. *C. papaya* is low in caloric as food and rich in vitamins such as vitamin C, niacin, riboflavin, beta-carotene and minerals like magnesium, calcium, phosphorus, and iron (Nwofia and Ojimelukwe, 2012). It possesses some valuable phytochemical compounds such as phytosterols, tocopherols, flavonoids, alkaloids, carotenoids, etc. These compounds have several nutritional and medical properties (Afolabi and Ofobrukweta, 2011; Barroso et al., 2016; Chai et al., 2020; Daagema et al., 2020; Silva and Jorge, 2020). As a result, *C. papaya* has shown anti-inflammatory, hyperglycemia, anti-hypertension, anti-dengue fever, antidiabetic, antioxidant, immunomodulatory, and antimicrobial activities, increasing scientific investigation on it. Papaya seeds are used mainly for their medical properties, and are an important source of essential oils used in medicine and other things. According to He et al. (2017), papaya seeds contain chemical compounds such as benzaldehyde, benzyl nitrile, and benzyl isothiocyanate which have some antimicrobial activities. Seeds have an effective antibacterial property against *Escherichia coli*, *Salmonella* species and *Staphylococcus aureus* infections. Some antihelminthic and anti-amoebic activities have also been put in evidence according to Bouanga-Kalou et al. (2011), He et al. (2017), Muhamad et al. (2017), and Yi et al. (2022). The fundamental reasons for papaya seeds use as medicine are both poverty, which limit millions of people to conventional medicines, and the increase of antibiotic resistance against conventional drugs (Somda et al., 2021; Somda et al., 2023). In Burkina Faso, is already part of the plants used in traditional medicine against several diseases for children and adults (Tapsoba and Deschamps, 2006; Sawadogo et al., 2021). The study aims to identify phytochemical compounds in *C. papaya* seed essential oils and assesses their antifungal and antibacterial activities for improved traditional medicine purposes.

MATERIALS AND METHODS

Seeds sampling and collection of strains

Papaya seeds were purchased from local markets, mainly in Ouagadougou (Burkina Faso). Based on the aspects and colors of fruits, sellers recognized different varieties of papaya that were all sampled. Papaya seeds have been dried under shade. Six papaya seed samples of 5 kg each were collected. The clinical bacteria and fungi strains were from human feces, collected at Schiphra Protestant Hospital and Charles de Gaulle Pediatric Hospital, Ouagadougou, Burkina Faso. They included *Candida albicans*, *Candida* species, *E. coli*, *Salmonella* spp., *Shigella* species, and *S. aureus*.

Extraction of papaya seed essentials oils

C. papaya essential oils were obtained by hydro distillation using a Clevenger-type apparatus. Papaya seeds were first dried, crushed, weighed and introduced into a pressure cooker. 500 g of *C. papaya* powder was mixed with 5 L of distilled water and then heated up to 550°C with a heating plate, according to He et al. (2017). The essential oil was then collected in a sterile airtight container and store at 4°C.

Total polyphenolic and flavonoid content

Total polyphenols content were analyzed with gallic acid as standard according to Salla et al. (2016). Thus, 12.5 µL of Folin-Ciocalteu's reagent was added to 12.5 µL of papaya seed sample and 50 µL of distilled water. After 5 min, 125 µL of sodium carbonate (7%) was added and the absorbance was measured at 750 nm after 90 min of incubation at room temperature. Flavonoid content was performed according to Ribarova et al. (2005) method. About 25 µL of extracts and 7.5 µL of sodium nitrite (7.5%) were firstly taken. Then, 15 µL of aluminium chloride (10%), 50 µL of NaOH 1 M and 40 µL of water were added. The mixture was incubated for 5 min in the dark at room temperature, and the absorbance was measured at 520 nm.

Antioxidant properties

The DPPH radical scavenging activity was used to assess the antioxidant activity. Lamien-Meda et al. (2008) method was optimized to determine the DPPH assay. About 210 µL of DPPH (0.1 mM) was added to 40 µL of papaya seeds essential oils sample and the blank. After 90 min of incubation at room temperature, the absorbance was recorded at 517 nm for 30 min interval. The results were expressed as µg of ascorbic acid equivalent antioxidant content (AEAC) per 100 mL of papaya seeds essential oils (Lamien-Meda et al., 2008).

GC-MS analysis

Papaya seeds essential oils analysis by gas chromatography-mass spectrometry (GC-MS) was carried out on Shimadzu GCMS-QP-2010 plus system coupled with TESTEK Rtx-5MS column (30 mm×0.25 mm ID × 0.25 µm film thickness (He et al., 2017). Helium was used as carrier gas with a flow rate of 1.0 mL min^{-1}. The column temperature was increased from 140 to280°C at 5°C min^{-1} and maintained for 56 min. The injection temperature was kept at 260°C. A 0.3 µL volume of essential

*Corresponding author. E-mail: pnikiema@gmail.com.

oils was injected with 85.2 kPa as pressure. Each compound was identified based on the retention time using the National Institute of Standard and Technology (NIST) as reference database. The peak area of compound was integrated to determine their percentage.

Microbial strains and culture media

The main microorganisms responsible for gastroenteritis were the target ones. The standard strains included *E. coli* ATTC 8739, *Salmonella typhimurium* ATCC 14028, and *S. aureus* ATCC6538. The clinical strains from human feces were collected at Schiphra Protestant Hospital and Charles de Gaulle Pediatric Hospital and included *C. albicans*, *Candida* spp., *E. coli*, *Salmonella* spp., *Shigella* spp., and *S. aureus*. All clinical strains were previously biochemically characterized using API 20E, and human plasma only for *Candida*. Strains were stored at -18°C. Before being used, bacterial strains were streaked on plates containing Mueller-Hinton agar (MH) and yeasts on Sabouraud dextrose agar (SDA) and incubated for 18 up to 24 h at 37°C for bacterial and 27°C for yeasts. The operation was repeated twice to get viable and purified strains. The turbidity was then adjusted in saline solution to 0.5 according to Mac Farland standard.

Antibiogram and antifungigram of isolates

Antibiogram and antifungigram were performed to compare the sensitivity of studied microbial strains to conventional antibiotics and to papaya seeds essentials oils. The antifungigram discs (Himedia, India) used included nystatin (NS 100 µg), Fluconazole (FLC 25 µg), and ceftolozan (CLT 30 µg). Antibiogram discs were Ampicilline (AMP 10 µg), Ceftriaxione (CRO 30 µg), Cotrimoxazole (SXT 25 µg), Amoxicilline acide-clavulanique (AMC 30 µg), and ciprofloxacin (CIP 5 µg). A pure culture of 18 to 24 h of every microbial strain was prepared in sterile physiological water (9% NaCl) to meet 0.5 of McFarland standard. Antibiotic discs were applied on the surface of the agar. The inhibition diameters were measured after 24 h of incubation at 37°C for bacterial and 27°C for fungi.

The antimicrobial activity

The antifungal and antibacterial activity of papaya seeds essential oils were performed based on the inhibition diameters using agar diffusion method (KonarÃ et al., 2020). The microbial suspension was prepared in a saline solution and standardized to a turbidity of 0.5 on McFarland scale. Papaya seeds essential oils was diluted in Tween 80. A volume of 75 µL of essential oils is then used to fill wells in the plate previously performed and containing infectious microbial. Plates were incubated for 24 to 48 h at 27 and 37°C, respectively for fungi and bacterial. The evaluation of the antimicrobial activity was made by measuring zones of inhibition around wells of 4 mm diameters. Experiments were carried out in triplicate.

Determination of MICs, MBCs and MFCs

MICs, MBCs and (MFCs of papaya seeds essential oils were recorded according to broth dilution method. MICs were determined according to the CLSI M27-A3 guidelines (Clinical and Laboratory Standards Institute, 2008). The tests were performed in sterile 96-microwell plates, into which 100 μl of the RPMI-1640 medium (pH 7·0) was added for each well. Before inoculation, 100 μl of the essential oil solution (with <0·01% Tween 80) was added to the first well and serially diluted from the first well by taking 100 µl into the next. This twofold dilution was continued until the 10th column of the plate was reached. The wells in the 11th column of the plate were reserved for the negative control (without inoculation) and the wells in the 12th column were reserved for the positive control (with FLZ). The final concentrations of essential oils and FLZ in the wells were in the ranges of 256 to 0·5 µg ml^{-1} and 64 to 0·125 µg ml^{-1}, respectively. The microbial colonies were suspended in the RPMI 1640 medium and the concentration was adjusted to 1 to 5×10^3 CFU/ml. The solution (100 µl) was added to each well except those in the 11th column, which was supplemented with 100 µl of the RPMI 1640 medium. The 96-microwell plates were incubated at 35°C for 48 h. Finally, the optical density values were measured at 630 nm by enzyme-linked immunosorbent assay (ELISA, Biotek Synergy HTX, Vermont, MA, USA). The MICs were determined as the lowest concentration of the test substances that caused 50% inhibition. After the 96-well plates were incubated at 35°C for another 24 h, 20 µl of solution from each test well was streaked onto an SDA plate or on Mueller-Hinton agar (MH), followed by incubation at 35°C for 48 h. The MFCs and MBCs were determined as the minimum drug.

Statistical analysis

The data collection was performed with Excel version 2010. Analysis of variance and average were done using XLSTAT 2014.5.03.

RESULTS

Total polyphenolic and flavonoids content and antioxidant activity

Polyphenols, flavonoids content and antioxidant activity are presented in Table 1. Flavonoid compounds were not found in papaya essential oils. The average content of polyphenol compounds was about 95.49 µg GAE/100 mL and the average antioxidant capacity based on the DPPH radical scavenging power was 5569.06 µg AEAC/100 mL.

The phytochemical composition of papaya seeds essentials oil

Gas chromatography-mass spectrometry (GC-MS) analysis revealed volatile constituents of papaya seeds essential oils. The results are summarized in Table 2. A total of 21 phytochemical compounds were identified. The main compounds were Methyl isothiocyanate (24.32%), Benzene (22.54%), Glycerin (1.26%), 1,2-Dicycopropylacetylene (0.80%), 14-Octadecenoic acid, Methyl (0.18%), Benzyl isocyanate (0.14%), Urea (0.13), and Benzyl nitrile (0.11%).

Antifungal activity

C. papaya essential oils have presented inhibition activity against both clinical and referenced *Candida* strains, shown in Table 3. The inhibition zone diameter ranged between 16.5 and 60 mm. The widest zone of inhibition

Table 1. Phytochemical content and antioxidant capacity.

Test	Content
Polyphenols (µg GAE/100 mL)	95.49±4.82
Flavonoids (µg GAE/100 mL)	00
Antioxidant capacity (µg AEAC/100 mL)	5569.06±465.59

Table 2. GC-MS phytochemical composition of papaya seeds essential oil

N°	Identity	Area %	Reference number of the chemical abstracts service (CAS)	% of similarity according to NIST
1	Benzaldehyde	0.18	000100-52-7	95
2	Benzyl isocyanate	0.55	003173-56-6	92
3	Benzyl nitrile	0.43	000140-29-4	98
4	Isothiocyanatomethyl	97.27	000622-78-6	91
5	1-Benzyl-1,2,3,6triazole	0.19	004368-68-7	78
6	11,13-Tetradecadien-1-ol	0.28	1000131-00-3	86
7	3-Hexadecene, (Z)	0.07	034303-81-6	90
8	Benzenemethanamine	0.13	000780-25-6	90
9	Hexadecanoic acid, methyl ester	0.09	000112-39-0	91
10	9-Octadecenoic acid, methyl ester	0.06	000112-62-9	74
11	Thioura, N, N'-bis (phenylmethyl)	0.26	001424-14-2	90

Table 3. Antifungal activity of papaya seeds essential oils.

Fungi strains	Inhibition zones (mm)	MICs (mg.mL)	MFCs (mg.mL)	Conventional antibiotics		
				Nyst	Fluco	CLT
Candida spp. 103	48.5±1.5	0.20±0.01	0.38±0.01	29	28	24
Candida spp. 194	35.0±0.0	0.31±0.001	0.62±0.001	27	16	26
Candida spp. 1166	16.5±0.5	0.39±0.001	0.63±0.01	28	14	27
Candida spp. 27	50.5±0.5	0.195±0.001	0.31±0.01	27	16	26
Candida spp. 001	55.5±0.5	0.09±0.00	0.20±0.01	26	25	23
Candida spp. 438	60.0±0.0	0.39±0.001	0.785±0.001	28	14	25
Candida albicans 10231	50.5±0.5	0.09±0.00	0.196±0.001	19	20	27

Nyst= Nystatine; Fluco = fluconazole; CLT= clotrimazole; MICs = minimum inhibitory concentration; MFCs = minimum fungicidal concentration.

was against *Candida* spp. 438 (60 mm) and the smallest one against *Candida* spp. 1166 (16.5 mm). The standard reference strains (*C. albicans* 10231) presented 50.5 mm as inhibition zone diameter.

Antibacterial activity

The essential oil of papaya seeds showed an antibacterial activity against all clinical isolated strains and standard strains. The inhibition diameters ranged between 10 and 20 mm for the clinical strains and from 12 to 18 mm for the standard strains. Table 4 presents the inhibition zone diameters of all strains.

The antibacterial activity of standard antibiotic against both clinical and standard strains is presented in Table 5. In average, papaya seeds essential oils antibacterial properties were less effective than standard antibiotic.

Minimum fungicidal and bactericidal inhibitory concentrations

The minimum inhibitory concentration against fungi ranged between 0.09 and 0.38 10-2 mg.mL^{-1} and the minimum fungicidal concentration ranged between 0.31 and 0.78 10-2.mg.mL^{-1}. The smallest inhibitory and fungicidal concentrations were found against *Candida*

Table 4. Antibacterial activity of papaya seeds essential oil.

Strains	Inhibition zones (mm)	MICs ($\times 10^{-2}$ mg.mL^{-1})	MBCs ($\times 10^{-2}$ mg.mL^{-1})
Escherichia coli 1176	16.0±0.5[b]	0.09±0.001	0.19±0.01
Salmonella spp. 410	10.0±0.1[b]	1.56±0.001	3.12±0.00
Salmonella spp. 1146	12.5±0.5[b]	3.13±0.010	6.24±0.01
Salmonella spp. 433	16.5±0.5[a]	0.78±0.010	1.56±0.01
Salmonella spp. 436	18.0±1.0[a]	1.56±0.020	3.13±0.01
Salmonella spp. 03	20.0±1.0[a]	1.56±0.020	3.13±0.01
Shigella spp. 1047	15.5±0.5[b]	1.56±0.010	3.12±0.00
Shigella spp. 1183	15.0±1.0[b]	3.13±0.01	6.24±0.01
S. aureus ATCC 08275	11.5±0.5[b]	6.24±0.01	12.3±0.20
S. Typhimurium ATCC 14028	14.5±0.5[b]	3.11±0.01	6.23±0.01
Escherichia coli ATCC 25922	18.0±1.0[a]	0.39±0.01	0.78±0.01
Escherichia coli ATCC 8739	15.5±0.5[a]	3.12±0.01	6.26±0.01

[a]c=0.5% EO; [b]C=0.2% EO: essential oil; MICs: minimum inhibitory concentrations; MBCs: minimum bactericidal concentrations.

Table 5. Antibiogram of clinical strains.

Bacteria	AMP	CRO	SXT	AMC	CIP
Salmonella spp. 436	31	34	27	31	36
Salmonella spp. 410	30	31	25	24	32
Escherichia coli 1176	19	31	10	9	35
Salmonella spp. 03	30	33	25	24	36
Shigella spp. 1047	R	R	R	R	R
Salmonella spp. 433	32	31	32	24	38
Salmonella spp. 1446	35	32	24	26	32
Shigella spp. 1183	R	R	R	R	R
Quality evaluation of antibiotics					
Escherichia coli	19/17/17	30/30/29.5	24/24/24	20/20/20	35/35/34
S. aureus	32/32/32	30/30/30	22.5/22.5/24	32/35/35	37/35/35

R=Resistant; AMP=ampicilline; CRO=ceftriaxione; SXT=cotrimoxazol; AMC=amoxicillin acid clavunic; CIP=ciprofloxacine.

spp. 27 (Table 3). Concerning the antibacterial activity, MICs ranged between 0.09 and 6.25 10-2 mg.mL^{-1} and the MBCs ranged between 0.2 and 12.5 10-2 mg.mL^{-1}. The smallest minimum inhibitory and bactericidal concentrations were against E. coli 1146 and the highest minimum inhibitory and bactericidal concentrations tested were against *S. aureus* ATCC 08275 and *S. Typhimurium* ATCC 14028 (Table 4).

DISCUSSION

C. papaya seeds essential oils showed an important polyphenols content (95.49±41.82 µg GAE/100 mL) with a high antioxidant activity (5569.06±454.59 µg AEAC/100 mL) and a diversity of phytochemical compounds, mainly Methyl Isothiocyanate, Benzene, Glycerin, 1,2-Dicycopropylacetylene, 14-Octadecenoic acid, Methyl ester, Benzyl isocyanate, Urea, and Benzyl nitrile (Table 2). The antimicrobial inhibition diameter was around 20 mm for bacteria and up to 60 mm for fungi. The tested essential oils were effective against both clinical strains and standard ones. The clinical strains were *E. coli*, *Salmonella* spp., *Shigella* spp. and references ones were *S. aureus* ATCC 08275, *Salmonella* Typhi ATCC 14028, *E. coli* ATCC 25922, and *E. coli* ATCC 8739.

Polyphenols are secondary metabolites compounds widely distributed in plants, where they perform various functions related to growth, reproduction and protection against pathogens, predators, diseases, and UV radiation (Aguilar-Veloz et al., 2020). The polyphenol content as well as the other phytochemicals have some antimicrobial activities (Singh and Ali, 2011; Yanty et al., 2014; Igwe, 2015; Salla et al., 2016; He et al., 2017; Zhang and Chen, 2017; Tan, 2019; Othman et al., 2019; Manso et al., 2021). The antimicrobial activity of papaya seeds essential oils is then tributed to the phytochemicals compound. The content in polyphenols in papaya seeds essential oils in the present study is less important as compared to other plants and this high value is correlated with the antioxidant activity. Previous researches showed a value of polyphenols content, ranging between 4.83 and 22.59 mg GAE/g DW (Afolabi and Ofobrukweta, 2011; Salla et al., 2016; Muhamad et al., 2017; Muntholib et al., 2020) but also some flavonoids content of about 2.68 mg GAE/g DW in papaya seeds extracts (Salla et al., 2016). The appreciable value of antioxidant activity is of nutritional interest, added to their antimicrobial activity. Antioxidant activities are chemicals properties of the phytochemical compounds. These compounds reduce the risk of coronary heart diseases by preventing the oxidation of low-density lipoprotein (LDL) cholesterol, reducing the synthesis or absorption of cholesterol. They also appear to neutralize free radicals, inhibit enzymes that activate carcinogens, and activate enzymes that detoxify carcinogens (Saxena et al., 2013). The antioxidant activity of papaya seeds essential oils found here is higher than those of Dadoosh (2021) and Kothari and Seshadri (2010). The diversity in the chemical compounds is also more than He et al. (2017) who found only three compounds (Benzaldehyde, Benzyl nitrile, and Benzyl isothiocyanate).

Papaya seeds essential oils in this study have been found to be effective against both clinical and references microbial trains (Tables 3 and 4). *Shigella* spp. 1047 and *Shigella* spp. 1183 which were resistant to commercial antibiotic (Table 5) were sensitive to papaya seeds essential oil at different concentrations (Tables 3 and 4). The inhibition activity was more important for fungi (16.5 to 60 mm) than bacteria (10 to 20 mm). Antimicrobial activities of papaya seeds essential oils was also previously proved (Tapsoba and Deschamps, 2006; Singh and Ali, 2011; Muhamad et al., 2017; Zhang and Chen, 2017; Seshamamba et al., 2018; Heena and Sunil, 2019; Chai et al., 2020; Dotto and Abihudi, 2021; Li et al., 2021; Yi et al., 2022). The inhibition diameter for all Candida strains is higher than those of all commercial antibiotics and also higher than those found by He et al. (2017) which was less than 34 mm. But, on average, the inhibition diameter was higher with the commercial antibiotic than papaya seeds essential oils for bacteria strains. The MICs for fungi (0.09 to 0.38) and MFC (0.20 to 0.78) were also low than MICs (0.09 to 6.25) for bacteria and MBCs (0.2 to 12.5). He et al. (2017) also showed that the antifungal activities against Candida strains include *C. albicans, Candida glabrata*, *Candida krusei, Candida parapsilosis* and *Candida tropicalis*. Among fungi strains, Candida spp. 438 (60 mm of inhibition diameter) was the more sensitive to papaya seeds essential oils while Candida spp. 1166 (16.5 mm) was the less sensitive. And, among bacteria, Salmonella 410 was the less sensitive clinical strains. Salmonella Typhi ATCC 14028 was the less sensitive standard strain, while Salmonella 03 and E. coli ATCC 25922 were the more sensitive clinical and standard strains, respectively. The two clinical strains (Shigella spp. 1183 and Shigella spp. 1047) which were resistant to commercial antibiotic were sensitive to papaya seeds essential oil. But, MICs and MBCs of *C. papaya* essential oils microbial activity against pathogens are more weak than those of some other plants' essentials oils (Kim et al., 1995; Bosnić et al., 2006; Fu et al., 2007; Thosar et al., 2013).

Conclusion

This study showed an interesting chemical compounds and antioxidant activities with an effective antimicrobial property of *C. papaya* essential oils against both clinical and referenced fungi and bacteria. With these properties and antimicrobial activity, papaya seeds essential oil extracts are potential candidates in the improvement of traditional medicine against enterobacteria, but there is a need to specifically focus on their antimicrobial activity against microbial strains which are resistant to commercial antibiotic and complete the study with clinical test and toxicological activities.

REFERENCES

Afolabi IS, Ofobrukweta K (2011). Physicochemical and nutritional qualities of *Carica papaya* seed products. Journal of Medicinal Plants Research 5(14):3113-3117.

Aguilar-Veloz L.M, Calderón-Santoyo M, Vazquez Gonzalez Y, Ragazzo-Sánchez JA (2020). Application of essential oils and polyphenols as natural antimicrobial agents in postharvest treatments: Advances and challenges. Food Science and Nutrition 8(6):2555-2568.

Barroso PT, de Carvalho PP, Rocha TB, Pessoa FL, Azevedo DA, Mendes M F (2016). Evaluation of the composition of *Carica papaya* L. seed oil extracted with supercritical CO2. Biotechnology Reports 11:110-116.

Bosnić T, Softić D, Grujić-Vasić J (2006). Antimicrobial activity of some essential oils and major constituents of essential oils. Acta Medica Academica 35(1):9-14.

Bouanga-Kalou G, Kimbonguila A, Nzikou J, Ganongo-Po F, Moutoula F, Panyoo-Akdowa E, Silou T, Desobry S (2011). Extraction and characteristics of seed oil from Papaya (*Carica papaya*) in Congo-Brazzaville. Asian Journal of Agricultural Sciences 3(2):132-137.

Chai YH, Yusup S, Ruslan MS (2020). Review of bioactive compounds extracted from Carica papaya linn. Current Nutrition and Food Science 16(9):1287-1298.

Chávez-Pesqueira M, Núñez-Farfán J (2017). Domestication and genetics of papaya: a review. Frontiers in Ecology and Evolution 5:155.

Daagema AA, Orafa PN, Igbua FZ (2020). Nutritional potentials and uses of pawpaw (*Carica papaya*): A review. European Journal of Nutrition and Food Safety 12(3):52-66.

Dadoosh RM (2021). Evaluation of Phytochemical, Total phenolic and Antioxidant Activity of *Carica Papaya* Seed for Its Use in Biosynthesis of Gold Nanoparticles. Egyptian Journal of Chemistry 64(8):1-2.

Dotto JM, Abihudi SA (2021). "Nutraceutical value of *Carica papaya*: A review. Scientific African 13(2021):e00933.

Fu Y, Zu Y, Chen L, Shi X, Wang Z, Sun S, Efferth T (2007). Antimicrobial activity of clove and rosemary essential oils alone and in combination. Phytotherapy Research 21(10):989-994.

He X, Ma Y, Yi G, Wu J, Zhou L, Guo H (2017). Chemical composition and antifungal activity of *Carica papaya* Linn. seed essential oil against *Candida* spp. Letters in Applied Microbiology 64(5):350-354.

Heena D, Sunil T (2019). *Carica papaya*: Potential implications in human health. Current Traditional Medicine 5(4):321-336.
Hillocks RJ, Thresh J, Bellotti A (2002). Cassava:biology, production and utilization, Cabi, Publishing, New York, 2002.
Igwe O (2015). Chemical constituents of the leaf essential oil of *Carica papaya* from South East Nigeria and its antimicrobial activity. International Journal of Research in Pharmacy and Chemistry 5(1):77-83.
Kim J, Marshall MR, Wei C (1995). Antibacterial activity of some essential oil components against five foodborne pathogens. Journal of Agricultural and Food Chemistry 43(11):2839-2845.
Konar Ã MA, Nouhoum D, Cheickna CÃ, Daouda AKT, Issiaka T, Adounigna KÃ, Rokia S, Aboubacar SO (2020). "Evaluation of the biological activities of leaf and bark extracts of Ficus platiphylla Delile, a medicinal plant used in Mali. Journal of Medicinal Plants Research 14(3):118-128.
Kothari V, Seshadri S (2010). Antioxidant activity of seed extracts of Annona squamosa and *Carica papaya*. Nutrition and Food Science 40(4):403-408.
Lamien-Meda A, Lamien CE, Compaoré MM, Meda RN, Kiendrebeogo, M, Zeba B, Nacoulma OG (2008). Polyphenol content and antioxidant activity of fourteen wild edible fruits from Burkina Faso. Molecules 13(3):581-594.
Li P, Zhao Y, Wang C, Zhu H (2021). Antibacterial activity and main action pathway of benzyl isothiocyanate extracted from papaya seeds. Journal of Food Science 86(1):169-176.
Lim T (2012). *Carica papaya*. Edible medicinal and non-medicinal plants. Springer 1:693-717.
Muhamad SAS, Jamilah B, Russly AR, Faridah A (2017). The antibacterial activities and chemical composition of extracts from *Carica papaya* cv. Sekaki/Hong Kong seed. International Food Research Journal 24(2):810.
Muntholib D, Sulistyaningrum S, Marfu'ah S (2020). Identification of flavonoid isolates of papaya (*Carica papaya* L.) seed and their activity as pancreatic lipase inhibitors. AIP Conference Proceedings 2231(1). AIP Publishing LLC.
Nwofia GE, Ojimelukwe P (2012). Variability in proximate, mineral and vitamin content of *Carica papaya* (L.) leaves, fruit pulp and seeds. International Journal of Medicinal and Aromatic Plants 2(1):90-96.
Ribarova F, Atanassova M, Marinova D, Ribarova F, Atanassova M (2005). Total phenolics and flavonoids in Bulgarian fruits and vegetables. Journal of the University of Chemical Technology and Metallurgy 40(3):255-260.
Salla S, Sunkara R, Ogutu S, Walker LT, Verghese M (2016). Antioxidant activity of papaya seed extracts against H2O2 induced oxidative stress in HepG2 cells. LWT-Food Science and Technology 66:293-297.
Sawadogo M, Bangou MJ, Dakio B, Lema A, Thiombiano HM, Ouoba B, Ouoba HY, Ouedraogo GA (2021). Ethnobotanical survey on medicinal plants (*Carica papaya* L. and *Agelanthus dodoneifolius* (DC.) Polhill & Wiens) used in the treatment of Hepatitis in Burkina Faso, phytochemistry and antioxidant activity. World 1(1):24-35.
Saxena M, Jyoti S, Rajeev N, Dharmendra S, Abhishek G (2013). "Phytochemistry of medicinal plants. Journal of Pharmacognosy and Phytochemistry 1(6):168-182.
Seshamamba BSV, Malati P, Ruth ANG, Mallika AS, Sharma V (2018). Studies on physicochemical properties and proximate analysis of *Carica papaya* seed. Journal of Pharmacognosy and Phytochemistry 7(6):1514-1519.
Silva AC, Jorge N (2020). Potential of mangaba (Hancornia speciosa), mango (*Mangifera indica* L.), and papaya (*Carica papaya* L.) seeds as sources of bioactive compounds. Revista Ceres 67:439-447.
Singh O, Ali M (2011). Phytochemical and antifungal profiles of the seeds of *Carica papaya* L. Indian Journal of Pharmaceutical Sciences 73(4): 447.
Somda NS, Tankoano A, Métuor-DABIRÉ A, Kaboré D, Bonkoungou J, Kpoda D, Sambe-Ba B, Dabiré Y, Saba C, Ouoba I (2023). A systematic review and meta-analysis of antibiotics resistance of foodborne pathogenic bacteria in West Africa between 2010 and 2020. Journal of Food Protection, pp. 100061.
Somda NS, Bonkoungou IJO, Sambe-Ba B, Drabo MS, Wane A A, Sawadogo-Lingani H, Savadogo A (2021). Diversity and antimicrobial drug resistance of non-typhoid Salmonella serotypes isolated in lettuce, irrigation water and clinical samples in Burkina Faso. Journal of Agriculture and Food Research 5:100167.
Tan SS (2019). Papaya (*Carica papaya* L.) seed oil. Fruit Oils: Chemistry and Functionality, Springer Pp 615-626.
Tapsoba H, Deschamps JP (2006). Use of medicinal plants for the treatment of oral diseases in Burkina Faso. Journal of Ethnopharmacology 104(1-2):68-78.
Thosar N, Basak S, Bahadure RN, Rajurkar M (2013). Antimicrobial efficacy of five essential oils against oral pathogens: An in vitro study. European Journal of Dentistry 7(S 01):S071-S077.
Yanty NAM, Marikkar JMN, Nusantoro BP, Long K, Ghazali HM (2014). Physico-chemical characteristics of papaya (*Carica papaya* L.) seed oil of the Hong Kong/Sekaki variety. Journal of Oleo Science 63(9):885-892.
Yi G, Yin C, Lao Y, Shi Z, He X, Wu J, Jiang Y, Gong L (2022). Antibacterial and antitumor activities of chitosan/polyvinyl alcohol films containing microemulsion of papaya seed essential oil. Materials Today Communications 31:103475.
Yogiraj V, Goyal PK, Chauhan CS, Goyal A, Vyas B (2014). *Carica papaya* Linn: an overview. International Journal of Herbal Medicine 2(5):01-08.
Zhang T, Chen W (2017). The *Candida albicans* inhibitory activity of the extract from papaya (*Carica papaya* L.) seed relates to mitochondria dysfunction. International Journal of Molecular Sciences 18(9):1858.