COMPARATIVE IN VITRO STUDIES OF ANTIMICROBIAL ACTIVITIES OF RAW AND RIPEN PULP OF CARICA PAPAYA AGAINST SOME HUMAN PATHOGENS.

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Abstract

Present study evaluates the antibacterial activity of Carica papaya fruit (unripe and ripe) extracts obtained in different solvents (Petroleum ether, Chloroform and Ethyl acetate). The extracts were studied against various diseases causing pathogens such as Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella enterica and Micrococcus luteus using agar well diffusion method. The ethyl acetate extract of raw papaya pulp was found more active against S. enterica with zone of inhibition 20 mm. Extract of petroleum ether and chloroform also showed activity against P. aeruginosa with inhibition zone 15 mm and 17 mm respectively. Extracts of ripen pulp showed no or less activity against any of these tested pathogens. Chloroform showed moderate activity with the inhibition zone 15 mm against S. enterica followed by P. aeruginosa with inhibition zone 14 mm. When these results were compared to the results of standard drugs, raw papaya pulp found more effective against pathogens than the other. Minimum inhibitory concentration was calculated and maximum values lies between 10-20 mg/ml. This research concludes that raw papaya has potential natural antibacterial compounds which can aid in further investigation.

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Introduction:

Present time, life-threatening infections caused by pathogens has increases worldwide. It was suggested that some microorganisms cause majority of infections in both the community and the hospital environments. Although many antimicrobial agents have been discovered, the indiscriminate use of antibiotics has resulted many microorganisms in developing resistance to them (Sofowora, E.A. 1982). Some human pathogen like Pseudomonas, Salmonella and many other causing hazardous infections borne due to contaminated water or food. Pseudomonas aeruginosa is a strain of bacteria found widely in the environment; the most common type causing infections in humans in the hospital and/or with weakened immune systems (Lyczak JB., et al. 2000). Salmonella enterica is responsible for the majority of the virulence factors of the bacterium (de Jong, H.K., Parry, C.M., van der Pol, T.). Staphylococcus aureus is commonly known pathogen that is responsible for infections like pneumonia diabetes, cancer, vascular disease,
and lung disease have developed resistance to most classes of antibiotics (Enright MC. 2003). Several studies prove the presence of antimicrobial agent as primary or secondary metabolites in medicinal plants which can be used against these resistance developing pathogens.

*Carica papaya* (family Caricaceae) is rich in antioxidant nutrients such as carotenoids, flavonoids and vitamin C, as well as vitamin B (foliate and pantothenic acid). Papain is an endolytic plant cysteine protease enzyme has been used in medicine to treat ulcers, arthritis and reduce skin adhesions and studies have shown that it has anti-allergic, anti-inflammatory, antimicrobial properties (Uhlig, H. 1998 and Anibijuwon, I. I. and Udeze, A.O. 2009). It preferentially cleaves peptide bonds involving basic amino acids, particularly arginine, lysine and residues following phenylalanine. Chymopapain compounds present in *C. papaya* are used in bloating and conditions of chronic indigestion and Carapine, an alkaloids can be used as a hear depressant, amoebicide and diuretic.

The investigation is carried out to overcome the problem of bacterial resistance and identify the antibacterial activity of compounds present in papaya pulp (unripen and ripen) against different types of pathogens.

**Materials and Method:**

**Plant materials collection and extraction:**
Both fresh raw and ripen pulp of *Carica papaya* was collected from the area of Balawala, Dehradun. Washed, dried under the shed and blended into fine powder. Three different solvents were used for the extraction process of powdered material viz., petroleum ether, chloroform, ethyl acetate sequentially using hot maceration method. Crude extracts of both pulps were obtained by evaporating the solvent extracts using water bath at 55°C.

**Standardization of extracts:**
Stock solution used for antibacterial test was prepared at a concentration of 30 mg/ml (w/v) by dissolving 30 mg of each crude extract in 1 ml of 99.5% Dimethylsulfoxide (DMSO). Antibiotic disc (Vancomycin, Rifampicin, Erythromycin, and Nitrofurantoin) and DMSO used as positive and negative control respectively.

**Test pathogens:**
To assess the antibacterial properties, pure cultures of *Staphylococcus aureus, Micrococcus luteus, Salmonella enterica* and *Pseudomonas aeruginosa* were obtained from the Department of Microbiology, SBSPGI, Dehradun. Pathogens were grown on nutrient agar slants at 37°C. For antibacterial assays, Loop full bacteria were inoculated into nutrient broth and incubated overnight at 37°C.

**Screening of papaya pulp extracts for antibacterial activity:**
Antibacterial properties of various extracts of raw and ripe papaya pulp were demonstrated by well diffusion method against infection causing bacteria.

**Agar well diffusion method:**
Muller’s Hilton agar media was used to determine the antibacterial activity of pulp extract of papaya. 25 µl of 24 hrs fresh culture of each pathogen was evenly spread over sterile agar poured plates with the help of sterile glass spreader. After spreading, four wells were made in each plate using sterile cork borer. With the help of micropipette, wells were filled with raw and ripe pulp extract. Separate spread plate was used for positive control (antibiotic) and negative control (DMSO). These plates were left for diffusion of extracts for 30 minutes and then incubated in the upright position at 37°C for 24 hours. The formation of clear zone of inhibition around the well indicating the presence of antibacterial activity plates were observed and measured.

**Minimum Inhibitory Concentration (MIC):**
The MIC value of pulp extract is considered the lowest concentration of extract which exhibit maximum antibacterial activity. Various concentrations of both the pulp extract were prepared to demonstrate the minimum inhibitory concentration of antibacterial substance. To the culture tubes contains 9 ml fresh culture broth, 1 ml of the concentration ranged between 5 – 30 mg/ml was added. No plant extract was added to the control tube containing 9 ml of culture broth. After this, sealed the tube with sterile cotton plug and were incubated at 37°C for overnight. Tube with no or little growth of organism after 24 hours compared with the turbidity of control tube was considered as the MIC value.
Relative percentage inhibition:
The relative percentage inhibition of the crude extract with respect to positive control was calculated by using the following formula.
Relative percentage inhibition = \( \frac{100 \times (a - b)}{c - b} \)
Where,
a: total area of inhibition of the test extract
b: total area of inhibition of the solvent
c: total area of inhibition of the standard drug

Result:
The present study was done to evaluate the antibacterial efficacy of papaya pulp (unripe and ripe) against human pathogens Table 1. Among all three extracts of raw papaya pulp, ethyl acetate extract was more effective against S. enterica with inhibition zone 20 mm and relative per cent inhibition of 133.3 followed by S. aureus having 18 mm inhibition zone and 225 relative per cent inhibition. The relative per cent inhibition was calculated and given in Table 2. In ripen papaya, chloroform pulp extract showed strong inhibitory effect on the pathogens with the inhibition zone of 15 mm and 100 per cent inhibition against S. enterica followed by 14 mm inhibition zone and 233.3 per cent inhibition against P. aeruginosa. Petroleum ether and ethyl ether extract found no or little effect against test organisms. Figs show that all the pathogens were found resistance to the antibiotic drug used as positive control except Vancomycin and Nitrofurantoin, which were moderately active against S. enterica and M. luteus respectively. When the results were compared between the inhibition zone of antibiotics and the two sample extracts, all the three extracts of raw papaya pulp found more effective. The MIC values are presented in fig 1. The lowest concentration values ranging between 5 – 30 mg/ml. The MIC of ethyl acetate extract of raw pulp against S. aureus and P. aeruginosa was 10 mg/ml and 5 mg/ml against S. enterica. The MIC of ethyl acetate extract of ripe pulp against S. aureus, S. enterica and P. aeruginosa was 10, 25 and 15 mg/ml respectively.

Table 1: Antibacterial activity of papaya pulp extract against pathogens.

| Test pathogens | Zone of Inhibition (mm) at 30 µg |
|----------------|----------------------------------|
|                | Raw pulp                         | Ripe pulp                        | +ve Control |
|                | PE  | Ch  | EA  | PE  | Ch  | EA  | Standard discs |
| S. enterica    | 15  | 17  | 20  | 10  | 15  | 8   | Vancomycin     |
| P. aeruginosa  | 15  | 16  | 16  | 10  | 14  | 14  | Rifampicin     |
| S. aureus      | 14  | 13  | 18  | 14  | 12  | 9   | Erythromycin   |
| M. luteus      | 13  | 16  | 14  | 11  | 14  | 15  | Nitrofurantoin |

PE- Petroleum ether, Ch- Chloroform, EA- Ethyl acetate, µg - microgram, +ve - positive
0-12 = Resistance; 13-17 = Moderate; above 18 = Sensitive

Table 2: Relative Percentage inhibition (%) of fresh pulp extract of C. papaya against different strains of pathogen.

| Microbes used | Raw pulp | Ripe pulp |
|---------------|----------|-----------|
|               | PE       | Ch       | EA      | PE       | Ch   | EA     |
| S. enterica   | 100      | 113.3    | 133.3   | 66.6     | 100  | 53.3   |
| P. aeruginosa | 250      | 266.6    | 266.6   | 166.6    | 233.3| 233.3  |
| S. aureus     | 175      | 162.5    | 225     | 175      | 150  | 112.5  |
| M. luteus     | 100      | 123.1    | 107.7   | 84.6     | 107.7| 115    |

PE- Petroleum ether, Ch- Chloroform, EA- Ethyl acetate
Fig 1: Graphic representation of minimum inhibitory concentration of pulp extract of Carica papaya

![Graph showing minimum inhibitory concentration values for different samples of Carica papaya pulp extracts against various bacteria.](image)

Fig 2: Photos showing zone of inhibition of ripen pulp extracts of C. papaya against tested pathogens

![Photos showing zone of inhibition of ripen pulp extracts of Carica papaya against tested pathogens.](image)

Fig 3: Photos showing zone of inhibition of raw pulp extracts of C. papaya against tested pathogens

![Photos showing zone of inhibition of raw pulp extracts of Carica papaya against tested pathogens.](image)

Discussion:
India is one of the twelve mega biodiversity centre’s having more than 45,000 plant species. Use of plants as a source of medicine has been inherited and is an important component of the health care system. Plants are the important source of potentially useful structures for the development of new chemotherapeutic agents. The first step towards this goal is the invitro antibacterial activity assay (Tona, L. et al. 1998). Present investigation was designed to obtain information on the antibacterial activity of the two samples of C. papaya. Among papaya fruit extracts, the extracts of raw pulp showed higher inhibition of the bacterial growth than the extracts of ripen pulp. This is due to the presence of an enzyme called Papain which is not found in ripen papaya fruits, shows extensive proteolytic activity towards proteins, short chain peptides, amino acid esters and amide links and is applied extensively in the fields of food and medicine (Tsuge, H. et al. 1999).
Previous studies confirm that the unripe fruits extract treated wounds were found to heal faster which induced
complete healing in shorter period (13 days) than that required by ripe papaya (17 days).

(Ocloo, A. et.al. 2012). In unripen pulp extracts, ethyl acetate extract showed highest activity and inhibited all the
pathogens than petroleum etherextract. This was believed due to the presence of sinigrin and caricin, both glycosides
and the enzyme myrosin. The wound healing property of this plant can be attributed to the presence of bioactive
compounds like alkaloids, flavinoids, carbohydrates, glycosides, saponins, phenolic compounds and tannins and
cardenoides(Pandey P., Garg F.C., Tripathi L.K. 2016). In antibiotic sensitive test, Vancomycin showed activity
against S. enterica due to its unique glycopeptide structurally unrelated to any currently available antibiotic. There is
also evidence that Vancomycin alters the permeability of the cell membrane and selectively inhibits ribonucleic acid
synthesis (Mansfield, 1985). The low MIC value observed for S. enterica is a good indication of high efficacy against
this bacterium. High MIC may be an indication of low efficacy or that the organisms have the potential for
developing resistance to the bioactive compounds (Draughon FA. 2004). Therefore, this systemic screening of plant
extracts for antibacterial activity is a continuous effort to find new antibacterial compounds.

Conclusion:
The present study focused on antibacterial activity of C.papaya against both gram-negative and gram-positive
bacteria is an indication that the plant is a potential source for production of drugs with a broad spectrum of activity.
These results supports the traditional application of the plant that possess compounds with antibacterial properties
can be used as antibacterial agents in drug manufacture by the pharmaceutical industries.

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