Antibacterial Activity of *Anastatica hierochuntica* L. Against Some Bacterial Strains

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**Abstract:** The purpose of this work is to study the biological activity of *Anastatica hierochuntica* L., against nine bacterial strains responsible of urogenital infection (UTI) for women. The plant was collected from Tindouf region (Far Southwest Algerian). In this study we performed a phytochemical screening and evaluation of antibacterial activity of three macerates of two vegetative parts (seeds and stems) by two methods (disk and wells diffusion method).

Given the results, it appears that macerates obtained were rich in bioactive phyto-constituents particularly the seed of the plant. They showed the presence of ten large chemical groups. The yield of aqueous, methanolic and etheric macerates of the seeds and stems were (5,1; 3,8), (5; 1,4) and (2; 0,95)% respectively.

The antibiotic resistance profile of the bacterial strains tested showed an increased resistance against several antibiotics families. The evaluation of the antibacterial potential of macerates showed that methanolic and aqueous macerates of the seeds were more active against Gram-positive bacteria compared to Gram-negative bacteria.

The preliminary results of our study, allowed us to predict that natural substances in the plant can be considered as an important source possess compounds with significant antibacterial and antioxidant properties, which suggests their application in the pharmaceutical industry.

**Keywords:** Anastatica hierochuntica, phytochemical screening, antibacterial activity

I. Introduction

Urinary infection is a set of pathologies, whose common denominator is the urinary tract infection or its annex for which the urine culture is positive (Traxer, 2005). The UTI are, after respiratory infections, the second leading causes for consultation.

In the United States, bacterial cystitis in women generates nearly 7 million annual consultations and 1 million visits to emergency services lead to 100,000 hospitalization. Financially, the community's annual cost of an acquired UTI is significant, about 1,6 billion dollars. Today it represents 6-8%, approximately 800,000 cases reported each year in France (Benyagoub et al., 2013).
For this purpose the UTI has been extensively studied because of its frequency and severity etiological or progressive, motivating most often antibiotic prescriptions without knowing the causal germ or their antibiotics profile (Lobel, 1995). However, with the emergence of resistant urinary pathogens observed in some community and hospital settings, grown researchers to getting back to nature, to search for bioactive molecules of vegetable origin powerful against these pathogens. Plant biodiversity of the Sahara is characterized by the presence of medicinal plants having a great therapeutic potential against several diseases. For a long time, natural remedies, and especially medicinal plants were the principal recourse of medicine for our grandparents, despite the significant development of the pharmaceutical industry that allowed modern medicine to treat a large number of often fatal diseases (Bruneton, 1999).

The species of *Anastatica hierochuntica* L., from crucifers’ are an important dicotyledonous plant family, is known for its therapeutic properties as a hepato-protective plant, hypoglycemic and diuretic. It is used in traditional medicine for uterine bleeding and to facilitate the expulsion of dead fetus, to treat gastrointestinal disorders, depression, high blood pressure, indigestion, headache, fever, malaria, epilepsy, heart disease and infertility (Hegazy and Kabiel, 2007).

It’s in this context that we were interested in phytochemical properties of the species *A. hierochuntica* L., and highlight the antibacterial activity of its some excerpts namely the methanolic, aqueous and etheric macerates against nine bacterial strains responsible of urogenital infection for women.

II. Materials and methods

This study was conducted at the University of Bechar (Algeria), after preparing the plant as follows;

II.1. Harvesting plants

The plant studied was collected after being identified during the months of February-March 2015 in the far southwest Algerian-Tindouf region (Algerian-Moroccan border). The dried plant was put into clean bags.

II. 2. Phytochemical screening

About tri-phytochemical study, three extractions were conducted according to the protocol developed by Emad (2014). The crude extracts were obtained by successive extractions with solvents of increasing polarity. In this order, petroleum ether, methanol and distilled water were used. Preparing extracts allowed performing a qualitative phytochemical screening of two vegetative parts (seeds and stems).

II. 3. Extraction processes

The aqueous, methanolic and etheric macerates of the plant studied were obtained by maceration with the method described below;

II.4. Preparation of macerates

A test sample 10 g of the dried plant was mixed with 100 ml of distilled water. The mixture is stirred for 24 hours. After filtration through a filter paper, the filtrate is evaporated (rota vapor), till it dried under reduced pressure at 100°C in order to obtain the aqueous macerates residue. However, for the methanol and etheric macerates, a test sample 5g of dried plant was mixed with 85ml of methanol and diethyl ether, respectively. The mixture is stirred for 24 hours. After filtration, the filtrate is evaporated (rota vapor) till it dried under reduced pressure at 65 and 35°C respectively. The obtained residues are weighted to calculate the yield of aqueous, methanolic and etheric macerates (Majhenic et al., 2007).
II. 5. Bacterial strains

The evaluation of the antibacterial activity of extracts of the plant studied was conducted in accordance with official methods. However, the tested microorganisms were isolated from genital and urinary samples of women by cytopathological examination. The isolated strains have experienced, first, identification by macroscopic examination of colonies on nutrient agar and microscopic observation in the fresh state and after differential Gram stain, secondly, identification of biochemical characteristics through to classic gallery and miniaturized API 20E. The strains isolated and identified were a total of nine strains distributed as follows: Five strains of *Escherichia coli*, *Citrobacter freundii*, *Proteus mirabilis*, *Pseudomonas aeruginosa* and *Enterococcus faecalis*.

II.5.1. Antibacterial test

The colonies which were isolated from young cultures on nutrient agar medium (Fluka, India) incubated at 37°C for 18 to 24 hours are transferred into tubes containing sterile physiological saline (0.9% NaCl) to prepare bacterial suspensions with similar turbidity of 0.5 McFarland. Then, the bacterial suspension, prepared beforehand, was seeded using a sterile swab over the entire surface of a Mueller-Hinton agar medium (Himedia, India) by tight streaks.

The study of antibiotic resistance profile of strains isolated to antibiotics was performed by the diffusion method on MH agar medium using loaded discs of antibiotics as recommended by NCCLS (National Committee for Clinical Laboratory Standards) (NCCLS, 2002). The results of antibiotic resistance were interpreted according to the reference table prepared by the antibiogram committee of the French microbiology society (Soussy, 2005).

The antibiotic discs used for disk diffusion method, were firstly for *Escherichia coli*, *Citrobacter freundii* and *Proteus mirabilis* as following: cefoxitin, cefazolin, chloramphenicol, Amoxicillin-clavulanic acid, ampicillin, gentamicin, ofloxacin, imipenem and cefotaxime; secondly to *Staphylococcus aureus*: penicillin, oxacillin, vancomycin, fosfomycin, fusidic acid, erythromycin, amikacin, gentamicin; thirdly for *Pseudomonas aeruginosa*: ofloxacin, tobramycin, imipenem, rifampin, ticarcillin, fosfomycin, amikacin and cefotaxime; finally for *Enterococcus faecalis*: vancomycin, tetracycline, gentamicin, ampicillin and erythromycin.

The antibacterial activity of the extracts was determined by the disk diffusion method and well diffusion method on agar medium (Sacchetti *et al.*, 2005; Celiktas *et al.*, 2007). The first method consists of substituting the antibiotic discs by other confined discs from Watman paper impregnated with the extract.

Inoculated a Petri dish containing impregnated disks with DMSO, methanol and diethyl ether were used as a control. Finally, the dishes were incubated at 37°C for 24 hours. The second method was described by Vlietinck and Vanden Berghe (1991) which we used to confirm the action of the extracts tested. This method consists to cut a circular hole in the MH agar medium; each extracts solution was poured with a volume of 10μl in the well.

The radial diffusion of extract giving a circular inhibition zone to the agar surface seeded with the bacterial suspension by swabbing streaked.

III. Results and discussion

III. 1. Phytochemical screening

The phytochemicals tests results of the plant studied exhausted by water, methanol and diethyl ether, are summarized in Table 1.
Table 1. Photochemical screening of A. hierochuntica L.

| Comp: Components, Rst: Results, NC: Negative control, DW: Distilled water, Alc: Bases: base alkaloids, Com.: Coumarins, Ste.Trit: Sterols and triterpenes, Quin. libres: free Quinones, Alc. sels: salts alkaloids, Flav.: Flavonoids, Terp.: Terpanoïdes, Anth.: Anthracénosides, Hete. Ster: sterol heterosidetriterpenic, Tan.: Tannins, Sap.: Saponins, F. ac: Fatty acid, (-): Negative test, (+): Positive test, Se.: Seeds, St.: Stems.
|-----------------|-------|-----|----------|-------|-----|-----|--------|-------|-----|-----|
|                 | Alc. bases | Com. | Ste. | Trit | Quin libres | Alc sels | Flav. | Terp. | Anth. | Heter | Ster. | Tan. | Sap. | F. ac |
| Se.             | -      | +    | +    | -    | +            | +        | -     | +     | +     | -     | +    |     |      |      |
| St.             | -      | +    | +    | +    | -            | -        | +     | -     | +     | -     |      |     |      |      |
| NC (DW)         | -      | -    |     | -    | -            | -        | -     | -     |       |       |      |     |      |      |

The phytochemical screening performed showed the presence of ten major chemical groups in parts and stems as following: tannins, coumarins, fatty acids, reducing compounds, sterols or triterpenes, sterol heterosides triterpenic, flavonoids, free quinones, terpanoïdes and alkaloids salts. These tests showed the presence of flavonoids and alkaloids salts but only in the seeds. As well as the absence of saponin, anthracénosides, starch, emodols, anthocyanosides and alkaloids bases in the two parts of the plant studied.

These results are corroborated by the work of Daur (2012), which showed that all parts of the A. hierochuntica L., have been proved rich in total phenolic content. This representation of nearly all chemical families could justify the multiple use of A. hierochuntica.

Also, these results were similar to those given by Bouhadjera et al., (2005) which has been shown the presence of almost all secondary metabolites of Brassicaceae family such as alkaloids salts, flavonoids, saponins, tannins, anthocyanins, sterols and steroids. Moreover, we noted the absence of some one of these metabolites cited above.

This difference in composition was probably due to various conditions including the environment, genotype, geographical origin, harvest time, location, temperature and drying time (Svoboda and Hampson, 1999; Lis-Balchin and Hart, 2002).

II. 2. Extraction yield

The plant has a relatively low yield of crude extract estimated at 5,1; 5 and 2% for aqueous, methanolic and etheric macerates of the seeds respectively. However, the stem part of the plant has a yield lower than that given by the seed estimated at 3.8; 1,4 and 0.95% for aqueous, methanolic and etheric macerates respectively.

The difference in yield was probably due to the biochemical composition of the two parts of the plant. Indeed, the yield is not relative; it depends on the method and conditions in which the extraction was performed. Also, differences in results may be attributed to the harvest time.

The yields were higher compared to that found by Rahmoun et al., (2014) who has been obtained in yields estimated at 2 and 1,4% respectively for the hydro-methanolic and chloroformic macerates of the entire plant of A. hierochuntica (Root, leaves, seeds and fruits).

II. 3. Antibiotic resistance profile of the strains tested

The antimicrobial resistance profile results of the bacterial strains against antibiotics performed by the diffusion method on Mueller-Hinton agar medium are reported in Table 2 (a, b).

The antibiotic resistance profile of the bacterial strains tested showed an increased resistance to ampicillin, trimethoprim-sulfamethoxazole, cefazolin, cefoxitin and ofloxacin for E. coli, C. freundii and P. mirabilis. While S. aureus and E. faecalis showed resistance to vancomycin, clindamycin, erythromycin, penicillin and oxacillin. However, P. aeruginosa strain was sensitive to antibiotics tested (Figure 1).
Most epidemiological studies have shown that the incidence of urogenital infection is higher among women (Betsy, 2002) which was revealed by Benyagoub et al., (2013) with a sex ratio F/M equal to 1.62. This is directly related to the anatomical structure of the female urinary apparatus. Knowing that some work namely Adjei and Opoku (2004); Aroor et al., (2008) found in two studies in Ghana and India respectively a male-dominated, and for this reason, we have isolated urinary pathogens from the female population.

The antibiotic resistance results are in agreement with our works series (Benyagoub et al., 2013), about the emergence of antibiotic resistance of microorganisms responsible of urinary tract infections (UTI) in Bechar (Algeria) where a total of 145 strains were isolated and have experienced an antibiogram test. Antibiotic resistance is relatively high for specific molecules, in particular beta-lactams (penicillin, oxacillin, ampicillin and amoxicillin-clavulanic acid), sulphamides (cotrimoxazole) and macrolides (erythromycin) for *E. coli* and *S. aureus*.

The carbapenems, third generation cephalosporins (C3G), aminoglycoside antibiotics (gentamicin and amikacin), phenicole (chloramphenicol), fosfomycin and amoxicillin exhibit good activity as well as in our study and in other series (Larabi et al., 2003; Lemort et al., 2006; Muratani and Matsumoto, 2006), and that we must trying to preserve them.

**Figure 1**: Antibiogram tests of the bacterial strains tested on Mueller-Hinton agar 
(a): *E. coli* 1, (b): *E. coli* 3, (c): *S. aureus* ; (d): *E. coli* 5, (e): *P. mirabilis*, (f): *E. faecalis*, (g): *P. aeruginosa.*
Table 3a. Values of inhibition zone diameters and inhibition percentages (%) of antibiotics against the bacterial strains responsible of urogenital infection for women.

| Bacterial strains | ATB | D    | I (%) | P. aeruginosa | E. faecalis | P. mirabilis | St. aureus | C. freundii |
|-------------------|-----|------|-------|---------------|-------------|--------------|------------|-------------|
|                   |     |      |       |                |             |              |            |             |
| Fosfomycin        |     | -    | -     | -              | -           | -            | 9          | 10          | R           |
| Chloramphenicol   |     | -    | -     | -              | -           | -            | 35         | 38.88       | S           |
| Cefazolin         |     | -    | -     | -              | 06          | 6.66         | -          | -           | 06          | R           |
| Amoxicillin       |     | -    | -     | 25            | 27.77       | S            | -          | -           | 36          | 40          | S           |
| Clindamycin       |     | -    | -     | -              | -           | 06           | 6.66       | -           | R           |
| Oxacillin         |     | -    | -     | -              | -           | -            | 6.66       | -           | -           | -           |
| Penicillin        |     | -    | -     | -              | 06          | 6.66         | 06         | 6.66        | R           |
| Vancomycin        |     | -    | -     | 06            | 6.66        | R            | -          | -           | -           | -           |
| Gentamicin        |     | 30   | 33,33 | S             | 26          | 28.88        | 25         | 27.77       | 35          | 38.88       | S           |
| Erythromycin      |     | -    | -     | 06            | 6.66        | R            | -          | -           | 06          | 6.66        | R           |
| Tetracyclin       |     | -    | -     | 06            | 6.66        | R            | -          | -           | -           | -           | -           |
| Clindamycin       |     | -    | -     | -              | -           | 06           | 6.66       | -           | R           |
| Cefotaxime        |     | 25   | 27.77 | S             | -           | -            | 20         | 22.22       | -           | 06          | 6.66        | R           |
| Ofloxacin         |     | 30   | 33,33 | S             | -           | -            | -          | -           | -           | 18          | 20          | I           |
| Imipenem          |     | 48   | 53,33 | S             | -           | -            | -          | -           | -           | 21          | 23.33       | S           |
| Ceftazidime       |     | -    | -     | -              | 15          | 16.66        | -          | -           | -           | -           | -           |
| Amikacin          |     | 27   | 30    | S             | -           | -            | 21         | 23.33       | -           | -           | -           |
| Tobramycin        |     | 25   | 27.77 | S             | -           | -            | -          | -           | -           | -           | -           |
| Ampicillin        |     | -    | -     | -              | -           | -            | -          | 30          | 33,33       | S           |
| Fusidic acid      |     | -    | -     | -              | -           | 06           | 6.66       | -           | R           |
| Ticarcillin       |     | 50   | 55,55 | S             | -           | -            | -          | -           | -           | -           | -           |

(D): Inhibition zone diameter (mm), I (%): Inhibition percentage, (P. ATB): antibiotic resistance profile, (S): Sensitive, (R): Resistant, (I): Intermediate, ATB: antibiotics, E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa, E. faecalis: Enterococcus faecalis, P. mirabilis: Proteus mirabilis, St. aureus: Staphylococcus aureus, C. freundii: Citrobacter freundii.

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### Table 3b. Values of inhibition zone diameters and inhibition percentages (%) of antibiotics against the bacterial strains responsible of urogenital infection for women.

| Bacterial strains | ATB       | E. coli 1 | E. coli 2 | E. coli 3 | E. coli 4 | E. coli 5 |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Chloramphenicol   | 10        | 11.11 S   | 17        | 18.88 S   | 19        | 21.11 S   | 17        | 18.88 S   | 31        | 34.44 S   |
| Cefazolin         | 06        | 6.66 R    | 06        | 6.66 R    | 06        | 6.66 R    | 06        | 6.66 R    | 06        | 6.66 R    |
| Amoxicillin-clarulanic acid | 06 | 6.66 R | 06 | 6.66 R | 06 | 6.66 R | 06 | 6.66 R | 30 | 33.33 S |
| Gentamicin        | 28        | 31.11 S   | 26        | 28.88 S   | 27        | 30 S      | 25        | 27.77 S   | 28        | 31.11 S   |
| Ampicillin        | 06        | 6.66 R    | 06        | 6.66 R    | 06        | 6.66 R    | 06        | 6.66 R    | 06        | 6.66 R    |
| Cefotaxime        | 15        | 16.66 I   | 21        | 23.33 S   | 21        | 23.33 S   | 18        | 20 S      | 22        | 24.44 I   |
| Ofloxacin         | 06        | 6.66 R    | 12        | 13.33 S   | 12        | 13.33 S   | 11        | 12.22 S   | 35        | 38.88 S   |
| Imipenem          | 31        | 34.44 S   | 22        | 24.44 S   | 21        | 23.33 S   | 18        | 20 S      | 35        | 38.88 S   |

(D): Inhibition zone diameter (mm), I (%): Inhibition percentage, (P.-ATB): antibiotic resistance profile, (S): Sensitive, (R): Resistant, (I): Intermediate, ATB: antibiotics, E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa, E. faecalis: Enterococcus faecalis, P. mirabilis: Proteus mirabilis, St. aureus: Staphylococcus aureus, C. freundii: Citrobacter freundii.
III.4. Antibacterial tests
III. 4.1. Diffusion method in agar (Vincent Technique and wells method):

Faced to the problems of bacterial resistance to synthetic antibiotics, many researchers have been conducted on the antimicrobial activity of natural products and plant extracts. The results of aromatogram test performed by the agar diffusion method, which are measured by measuring the inhibition zones around the discs are shown in Table 5 (a, b).

Table 5 (a, b): Percentage inhibition of different macerates seeds part on bacterial strains responsible of UGI for women.

(a)

| bacterial strains | E.coli 1 | E.coli 2 | E.coli 3 | E.coli 4 | E.coli 5 |
|-------------------|---------|---------|---------|---------|---------|
| Macerates         |         |         |         |         |         |
| MM                | [ ] 235mg/ml | -       | 14,44   | -       | 11,11   | 12,22   |
|                   | [ ] 117,5mg/ml | -       | -       | -       | 7,77    | -       |
|                   | [ ] 56mg/ml | -       | -       | -       | 7,77    | -       |
| AM                | [ ] 95mg/ml | -       | 14,44   | -       | 7,77    | -       |
|                   | [ ] 45mg/ml | -       | 8,88    | -       | 10      | -       |
| EM                | [ ] 100mg/ml | -       | 7,77    | -       | 11,11   | -       |

(b)

| bacterial strains | P. a | E. f | P. m | St. a | C. f |
|-------------------|------|------|------|-------|------|
| Macerates         |      |      |      |       |      |
| MM                | [ ] 235mg/ml | -     | 13,33 | 13,33 | 13,33 | -     |
|                   | [ ] 117,5mg/ml | -     | 11,11 | 10     | 11,11 | -     |
|                   | [ ] 56mg/ml | -     | 11,11 | 10     | 10    | -     |
| AM                | [ ] 95mg/ml | -     | 11,11 | 11,11  | 8,88  | -     |
|                   | [ ] 45mg/ml | -     | 12,22 | 12,22  | 8,88  | -     |
| EM                | [ ] 100mg/ml | -     | -     | -      | -     | -     |

AM: Aqueous macerate, MM: Methanolic macerate. EM: Etheric macerate, E. coli: Escherichia coli, 1, 2, .. 5: Different strains of Escherichia coli, P. a: Pseudomonas aeruginosa, E. f: Enterococcus faecalis, P. m: Proteus mirabilis, St. a: Staphylococcus aureus, C. f: Citrobacter freundii, (-): no inhibition, [ ]: concentration.

The results indicate that the aqueous and methanolic macerates of the seeds showed an antibacterial effect on six strains including two Gram positive and four Gram negative bacteria (P. mirabilis, E. faecalis, S. aureus and E. coli 2, 4, 5). However, no inhibition was observed on E. coli 1, E. coli 3, P. aeruginosa and C. freundii. The etheric macerate was found ineffective against the strains tested in the concentration limits used estimated at 100mg/ml.

For stems macerates, the results indicate that the methanolic macerate presented an antibacterial effect only on E. coli 5 strain at a concentration of 235mg/ml with an inhibition percentage of 12,22%. However, the aqueous and etheric macerates have not shown any antibacterial effect on all strains tested. According to our results, we note that seeds macerates were more effective than stems macerates.

The results of aromatogram test performed by the agar diffusion method which are evaluated by measuring of the inhibition zones around the discs are shown in Figures 2 and 3.
Figure 2: Photographic illustration of the A. hierochuntica macerates’ disc diffusion tests against bacterial strains tested on Mueller-Hinton agar medium.

(a): E. coli 1, (b): E. coli 3, (c): E. coli 4, (d): E. faecalis, (e): E. coli 2, (f): S. aureus, (g): C. freundii.

Figure 3: Photographic illustration of the A. hierochuntica macerates’ diffusion wells tests against bacterial strains tested on Mueller-Hinton agar medium.

(a): S. aureus, (b): E. coli 3, (c): E. coli 5, (d): C. freundii.
The results of the aromatogram test demonstrate low efficiency of the three macerates of *A. hierochuntica* L., against the bacterial strains tested. These results are consistent with the work of Al-Fatimi *et al.*, (2007) and Mohamed *et al.*, (2010) which have not found any antibacterial activity against the same bacterial species we tested.

The aqueous and methanolic macerates of the seeds have an average antibacterial especially against *P. mirabilis*, *E. faecalis*, *S. aureus* and *E. coli* 2, 4, 5. While the methanolic macerate of the stems was only active on *E. coli* 5 strain.

According to the work of Rahmoun *et al.*, (2014) who tested the antimicrobial activity of hydro-methanolic and chloroformic extracts of *A. hierochuntica*, and they gave an average activity against *Aeromonas baumannii*, *Citrobacter freundii*, *Enterobacter cloacae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus mirabilis* and *Salmonella typhimurium*.

This activity is attributed to phenolic compounds which have a large spectrum of activity against Gram negative bacteria. However, they did not show any interesting activity against Gram positive bacteria we tested on.

Several species of *Brassicaceae* family contain glucosinolates. These compounds are responsible in some cases of anticancer activity (Yogeshwer *et al.*, 2004; Rafael *et al.*, 2005) but also of the toxicity of these species (Bruneton, 1999, Rafael *et al.*, 2005).

The Sitosterol and the Sigmasterol, are the phytoesterols the most encountered in higher plants, they represent more than 80% of existing sterols. The Brassicasterol found mainly in the *Brassicaceae* family is represented by a rate of 10% (Gaignaut *et al.*, 1989).

The antimicrobial tests showed that the steroids’ extracts of leaves and fruits prevent the growth of *Pseudomonas sp* and show a broad spectrum antifungal (Bouhadjera *et al.*, 2005).

Several studies have highlighted the high sensitivity of Gram-positive bacteria compared to Gram-negative bacteria (Falleh *et al.*, 2008; Hayouni *et al.*, 2007; Turkmen *et al.*, 2007; Shan *et al.*, 2007; Koné *et al.*, 2004). This can be attributed to the difference in the outer layers of Gram negative and Gram positive bacteria. Gram-negative bacteria and apart of the cell membrane, have an outer membrane which is composed of phospholipids, lipo-polysaccharides and proteins. This membrane is impermeable to most molecules. Nevertheless, the presence of this layer in porins in this layer will allow the free diffusion of molecules (Marzouk *et al.*, 2006).

However, inhibiting the growth of Gram negative bacteria has been reported, particularly in combination with the factors that can disrupt the integrity of the cell and/or the permeability of the membrane as the low pH values and increased concentrations in NaCl (Georgantelis *et al.*, 2007).

The antibacterial activity of *A. hierochuntica* is attributed not only to the phenolic compounds grouped into several classes; phenols, phenolic acids, flavonoids, anthocyanins, tannins, coumarins and quinones (Arimboor *et al.*, 2008), which are exploited in phytotherapy, having a vasculo-protectrices, antispasmodic and antioxidants properties (Shon *et al.*, 2004; Macheix *et al.*, 2005), but also to the alkaloids by their different physiological effects, which these compounds are mainly represented by tropanic, imidazole and indolic in the *Brassicaceae* family (Berghioua *et al.*, 2009). These are substances that possess various activities: anticancer (Charpentier *et al.*, 2008), local anesthetic and antimicrobial activity (Waller and Novacki, 1978).

The flavonoids have a very large and diverse antibacterial activity. Indeed, they attack a lot of bacteria with different intensity depending on the microorganism and the ecosystem in which it is located; the flavonoids are able to inhibit the growth of various types of Gram positive and Gram negative bacteria namely *S. aureus*, *E. coli*, *P. mirabilis* and *Enterococcus faecalis*. Also, terpenoids have strong activity against *S. aureus*, and also low activity against Gram negative bacteria (Bouhadjera *et al.*, 2005). It should also be noted that methanol can extract bioactive compounds; anthocyanins, terpenoids, saponins, tannins, xanthohylinos, flavones, polyphenols ...) more than other solvents used (Cowan, 1999). It argues that the inhibitory effect of methanolic macerate observed as well as in the work of Mohamed *et al.*, (2010) on the same species.

**IV. Conclusion**

The bioactive phytochemicals detected and the antibacterial activities of *A. hierochuntica* L., against some isolated microorganism strains responsible of UGI support their medicinal properties which are used in traditional medicine.
The modest results of the antibacterial activity of methanolic and aqueous macerates of the seeds reflects the need for further investigation regarding fractionation and purification of bioactive compounds well as the mode of compounds extracted action in microbial cells.

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