Quantitative and Qualitative study of Phenolic compounds in three varieties of Durum Wheat (*Triticum durum*. Desf) and their activities Antimicrobial

CHAIB Ghania[1], Siah Sarra [2] Benabdelkadder Amira[2], Bouchibi Baaziz Nacera[2] and Benlaribi Mostefa[3]

***Abstract*—** Durum wheat, as any cereal of Poaceae family, is considered as the first nutrient in the human diet. However, it was never or hardly ever used as medicinal plant. For that, our work is devoted for the quantitative and qualitative study of polyphénols in three varieties (Haurani, Hedba, and Guemgoum Rkham) of *Triticum durum Desf.* During two stages of their life cycle: going up (Bolting) and Flowering and their antimicrobial activity (antibacterial: *E. coli, Serratia sp*; antifungal: *Penicillium sp, Rhizopus sp*). The preparation of ethanolic extract of the three varieties is the first step that should be done. The dosage of Folin-Ciocalteu shows that polyphenols content is considerable and unchangeable whatever are the variety and/or the life cycle stage. The polyphenols identification starts by the treatment of the ethanolic extract with four solvents of different polarities which lead to the acquisition of different phases. The analysis of these phases is assured by the Ultraviolet-Visible spectroscopy and the thin layer chromatography. The majority of polyphenols resulted are simple phenols, phenolic acids and flavonoids especially Flavonols and Flavones. The antimicrobial activity test reveals that the ethanolic extracts have a strong antibacterial activity mainly on *E. coli* and antifungal especially on *Penicillium*. Finally, instead of classifying durum wheat as a cereal or a purely food plant, it could direct its operation as a medicinal plant.

Keywords— Antimicrobial, durum Wheat (*Triticum durum Desf.*), flavonoids , polyphenols, Ultraviolet- Visible spectroscopy,.

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I. INTRODUCTION

PLANTS producing primary metabolisms entering in the vital cell function .The plants also synthesize many qualified secondary compounds [1], citing polyphenols, alkaloids, terpenoids ... etc. Polyphenols are the most important group of secondary metabolites due to their diverse chemical structures [2] - [3]. This importance is due to their preventive, therapeutic [4], pharmaceutical [5] - [6], cosmetic [7] and also nutritional interests [8] .Phenolic compounds, especially flavonoids have antioxidant properties [9] antimicrobial [10] - [11] - [12] hepatitis-protective, gastro-protective and anti-cancer [13] ... etc.

Plants that contain these compounds are called medicinal plants [14] - [15]. Through the centuries, human traditions have developed the knowledge and use of medicinal plants aim to overcome suffering and improve the health of human kind [16]. The main dietary sources of polyphenols are fruits, vegetables and grains with quote durum wheat, soft wheat, barley [17]. This nutrition method gave beneficial effects on human health [18]. This observation and other studies indicated that these foods are rich in polyphenols. This gives a herbal appearance to these plants. Highlighting antimicrobial activities of the Phenolic compounds gives an enormous hope to the natural fight against the harmful microorganisms. It also opened the doors for the qualitative and quantitative improvement of agricultural production, minimizing the danger of pollution and the protection of human health from the pathogenic attacks. In this context, our work focuses on the following objectives:

First: quantifying the polyphenols levels in durum wheat (*Triticum durum* Desf.) And qualitatively identify the two life cycle stages of the plant.

Second, test the in vitro antimicrobial activity, namely antibacterial and antifungal, using the extracts of the studied plant.

II. MATERIALS AND METHODS

1. Preparation of the vegetable material

In this experiment, three varieties of durum wheat (*Triticum durum*) are studied Haurani (HAU) Hedba3 (HED) and Guemgoum Rkham (GGR). The preparation of the plant material is carried out in a greenhouse. The three varieties (all vegetative) were collected during two different phenological stages, Bolting and flowering at different times because of the early varieties.

2. Determination of polyphenols (quantitative aspect) the determination of total phenols allows to identify the content of these compounds in 1g of plant material. The realization of this aspect is made following these steps.

Maceration

The ethanolic extraction solution (ethanol / water 50/50) is prepared. For cereals, it is preferred to use ethanol for the maceration [19] , 50 ml of this solution is used for grounding 1g of fresh leaves. The mixture is soaked for 24 hours. Then it is filtered and recovered in flasks to decant overnight. The extract is evaporated to dryness thanks to Buchi Rotavapor at 50 ° C. The dry residues are recovered with 5 ml of distilled water; the aqueous solution is treated with 5 ml of petroleum ether.

Spectral study

The assay of total phenols was carried out by a suitable method Singlaton Rossai [20]. The Folin-Ciocalteu reagent reacts with the functional -OH in the phenols [21]. To quantify the total phenols in the vegetal material, the phyto-ethanolic extract was taken in test tubes by adding two reagents:

* 1 ml of the ethanolic extract of a plant,
* 5 ml of Folin-Ciocalteu 10%
* 4 ml of Na2CO3 sodium carbonate (75g / L)

A control is prepared by the same reagents except that the plant extract is replaced by ethanol .The resulting solution was incubated in 20 ° C for one hour. After its dilution with the respect of the report 1/5 by an ethanolic solution 50%. The absorbance is measured by the UV-Visible spectrophotometer at a wavelength of 765 nm [22].

Calculation of contents

Gallic acid is taken as a standard. Its absorbance according to its concentration is illustrated by the following equation: y = 0.795 + 0.33 x (y is the optical density OD, x is the concentration related to this OD) [22]. By replacing the optical density measured by "x = (y -0.33) /0.795" we obtain polyphenols concentrations "C (mg / ml)" of each extracted varietal. Then, to obtain the ratio of polyphenols "T (mg / g)" in a gram of the vegetal) material, the application of the following equation is adequate T = CV / m (V: the volume of the extract before evaporation to dryness m: mass of raw material = 1g for all varieties).

3. Extraction, identification and separation of phenolic compound (qualitative aspect)

The aerial part of the plant remaining in the first maceration is weighed and then soaked in the aqueous-alcoholic solution (ethanol / water, 50/50). The ratio of vegetal material / aqueous-alcoholic solution is 1/10: ml / g [23]. The maceration lasts successive 72 hours with a solvent renewal every 24 hours recovering each time the extract obtained from filtering. After this solution is decanted overnight, the sludge is removed at the end. It will be passed to a rotary evaporator. The dry residues are dissolved in 100 ml of distilled water for all recovery.

The extracts obtained are faced by various organic solvents, starting with the less polar to the higher polar. The volume of the plant extract is measured and placed in a decanal ampoule, and then the same volume of solvent is added. Then the mixture is stirred energetically letting out every time the produced gases. The clashes lead to obtain four phases which are the diethyl ether phase, the ethyl acetate phase, the butanone phase, and the aqueous or residual phase (H2O) .All phases are evaporated to dryness at 50 ° C except the Diethyl ether phase where the solvent is evaporated in the open air [24]. The recovery of the residues is carried out with 5 ml of methanol.

Because of the wide variety of phenolic compounds, their separation and identification are required for proper analysis. The UV-visible spectrophotometry and thin layer chromatography TLC techniques are used for this analysis.

Spectral Analysis

The analysis of phenolic compounds by UV-Visible Spectrophotometer with scrolling is between 220 and 400 nm [22]. This device is calibrated by methanol. Then, a drop of the analyzed is added to the methanol. The spectrum is obtained with its peaks.

Thin layer Chromatography

The plates used are made of glass (20/20 cm and 20/10). The selected adsorbent is silica gel TLC. A system has been chosen for the diethyl ether phase, ethyl acetate and butanone; the used system is 4 / 3/3/5: Toluene / MEK / MeOH / petroleum ether. TLC of the aqueous phase is carried out by the selected solvent system: 50/20/25: distilled H2O / n Butanol / EtOH. The eluent was poured to a depth of 1cm in the elution vessel. We must close the vessel so that it is saturated with the eluent vapor. Depositing the samples is performed using a capillary glass pipette, on a line already drawn by a pencil to about 2 cm from the bottom side of the plate. The diameter of the produced spot does not exceed 3 mm with a fast drying between each application. The plate is placed vertically in a vessel that should remain closed and not to be moved. When the position of the solvent front reaches approximately 1 cm from the upper end, the plate is removed from the vessel, the level reached by the solvent is characterized by a thin line, and the plate is dried in the open air or with a drier, the distances traveled by the different spots are measured.

Frontal report calculation

Rf = distance traveled by the substance / distance traveled by the solvent front.

4. Anti bacterial and anti fungal activities

The used Bacteria's are Escherichia coli and *Serratia* sp for the antifungal activity, the selected mushrooms are *Penicillium* sp and *Rhizopus* sp. The ethanol extract (100 ml)

of the extract is taken (only stadium Flowering) prepared above. The residue is recovered with 5 ml of ethanol. A Whatman paper sheet cut into discs sterilized in an autoclave at 120 ° C for 20 min. Then, they were soaked in three tubes sterilized each containing an ethanol extract of a variety. For mushrooms, the nutrient medium used is the PDA. For bacteria, the cultivation medium selected is the nutrient agar GN .The GN preparation is performed on a hot plate which helps to boil 500 ml of distilled water to dissolve 30 g of agar. Using a mixer, the mixture is well stirred to achieve homogeneity, half a liter of fresh distilled water is added to the mixture without stopping agitation. Agar obtained is poured into well-cleaned bottles; the sterilization of the GN is also ensured by autoclaving at 120 ° C for 20 min, the GN is ready for the desired cultivations. After the bench is cleaned by bleach and the benzene beak is turned on so that the flame will be blue; the name of the variety, the name of the bacterial or fungal species and the number of repetitions are written to the bottoms of Petri dish. Agar (GN and PDAs) are melted in a water bath at 100 ° C and when the liquid medium temperature reaches 45 ° C, it is cast in the dishes until at least their half. After filling, the dishes should be parted before the flame pending solidification of the agar. As soon as the agar is completely solidified, 10 .µl of the bacterial or the fungal suspension is spread on agar by a rake; the impregnated disks in the ethanolic extracts are slightly dried. Using forceps, the disks are taken one after the other, and then gently deposited on the suspension. The dishes must be properly closed and incubated in ovens at 30 ° C for 72 h for fungus and at 37 ° C for 24 hours for bacteria. The diameters of the inhibition zones are measured using a caliper.

5. Statistical Study

The results obtained in the qualitative and quantitative aspects were treated with the Software Excel Stat version 2008. The test performed is the two-factor ANOVA, followed by a comparison test of averages Newman-Keuls (NSK) to a 95% confidence threshold.

III. Results and Discussion

1. Determination of polyphenols (quantitative aspect)

The levels of total phenols in the three varieties of durum during bolting stage vary from 9.19 ± 6.46 mg EAG / g in the variety HAU to 11.92 ± 0.62 mg EAG / g in the GGR variety. While HED marks an intermediary between these two varieties (9.81 ± 1.63 mg EAG / g). On the other part, during the flowering stage, polyphenols content decreases in all varieties. They vary from 6.13 ± 1.99 mg EAG / g at HAU to 11.05 ± 9.78 mg EAG / g in GGR.

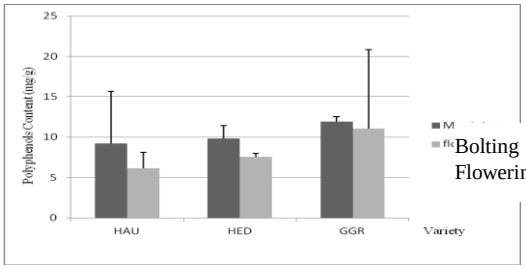


Fig .1 Polyphenols content in the three wheat varieties in Bolting and Flowering stages.

The results show that GGR variety registers a slight decrease that we can neglect. Analysis of the two-factor variance does not reflect any difference between the three varieties nor between the two stages, as well as an interaction between the two .According to the Newman-Keuls test (SNK), only one group includes three varieties studied with a simple difference between the ratios. Also, the test involves the two stages in a single group. Contrary to the results of Bousmid [22], the phenol content differs from one variety to another and from one stage to another.

2. Extraction and identification of polyphenols (qualitative aspect)

2.1. Extraction

The results are shown in the following tables:

TABLE I
PHASES OBTAINED AFTER CONFRONTATIONS

Solvent Duration	Variety	Bolting	Flowering
Petrol Ether	HAU	greenish yellow	greenish yellow
	HED	greenish yellow	greenish yellow
	GGR	greenish yellow	greenish yellow
Ether diethyl	HAU	Green+ clear	Green + clear
	HED	Clear green	Green
	GGR	Green +clear	Dark green
ethyl Acetate	HAU	Clear greenish yellow	Yellow
	HED	Clear greenish yellow	Dark yellow
	GGR	greenish yellow	greenish yellow
MEC (Butanone)	HAU	Clear Orange yellow	Clear Orange yellow
	HED	Brown	Orange yellow
	GGR	Clear yellow	Yellow

The colors of phases are clearly different which help to conclude that each phase contains some phenolic compounds. The remaining phases of these confrontations are aqueous phases.

TABLE II
RESIDUAL PHASES

H_2O	HAU (M/ F)	Clear brown	Dark brown
	HED (M/ F)	Dark brown	Dark brown
	GGR (M/ F)	Dark brown	Dark brown

2.2. Identification

Spectral Analysis

All the phases described above are then passed to the UV-Visible spectrophotometer with a wavelength range from 220-400 nm to determine the compounds contained in each phase. Phases of petroleum ether are excluded i.e. rejected because it eliminates the compounds that have no importance in our research. Fig 3 and 4 show the specters marked by the UV-Visible spectrophotometer of the phases for the two stages of life cycle of the plant; Bolting (M) and Flowering (F).

The specters of the Diethyl ether phase in both stages Bolting and Flowering have two peaks that vary between 221 and 293 nm which helps to deduct that flavonoids are definitely absent. So this phase is rich in simple phenols and phenolic acids. The methanol extracts from the Ethyl acetate layer show for the majority three peaks between 221 and 359 nm which are strongly near to those of the MEC phase (butanone). The first of these peaks is shown in the range 221-230 nm, which characterizes a simple phenol or phenolic acid. The other two are between 230 and 359 nm. This interval is characteristic of flavonoids. Our results are consistent with those of Wagner and Bladt [25] and Marston and Hostettmann [23] which indicates that flavonoids are found by two peaks; the first is between 230 and 280 nm, the second appears at about 300 and 385 nm.

To the naked eye, it is very difficult to identify all the spots. For this reason, the plates are passed to the darkroom for viewing using a UV lamp and a spray of sulfuric acid. The spray with sulfuric acid made the spots more remarkable, which led to define them. The results are shown in Tables III and IV, the number of the phase's spots in the bolting stage is the same regarding their number to those in the flowering stage.

Chromatographic analysis

The solvent front is marked right out of the plates. After they are dried, the distances traveled by different spots are measured [17].

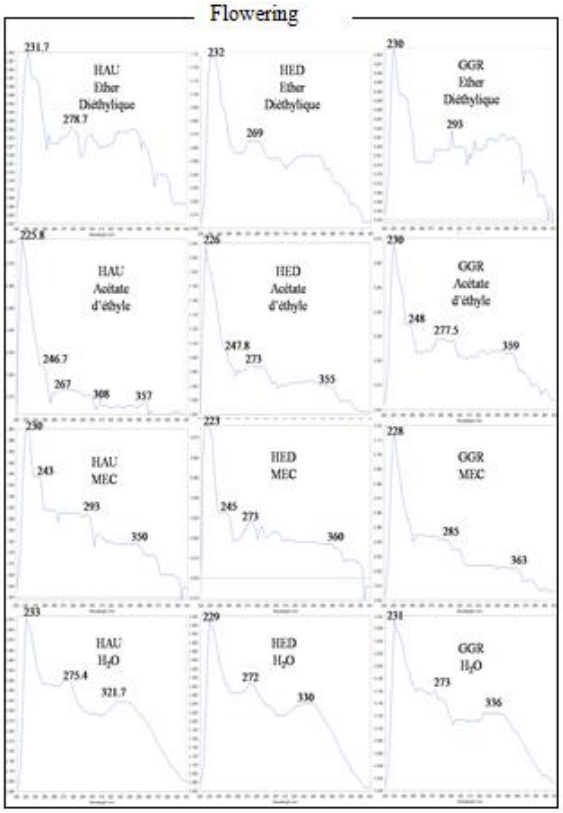


Fig. 2 Specters of phases in the Flowering stage

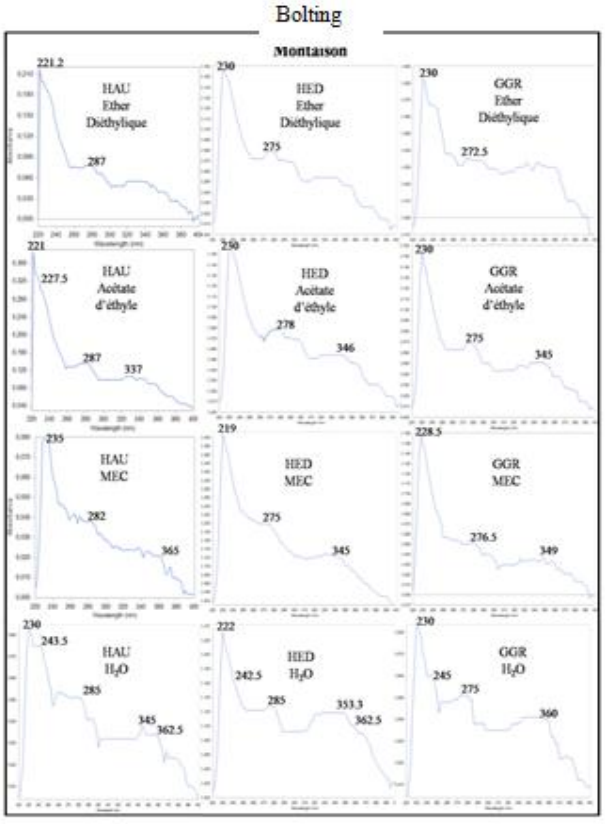
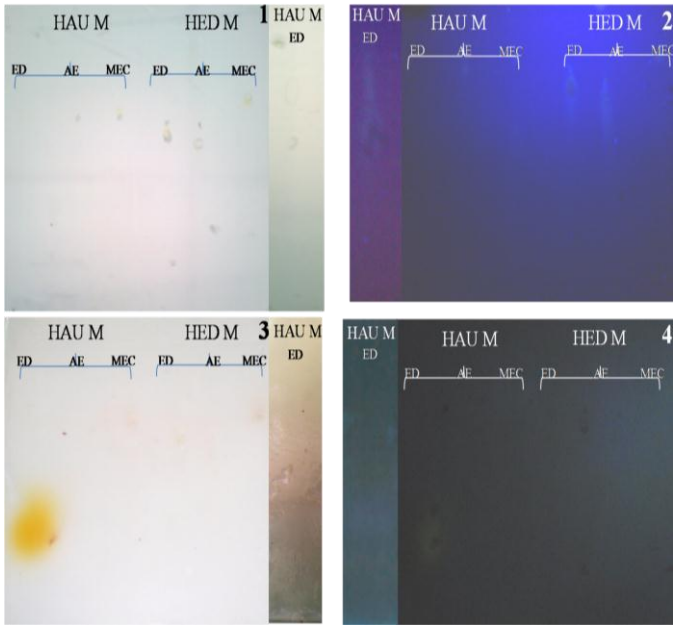


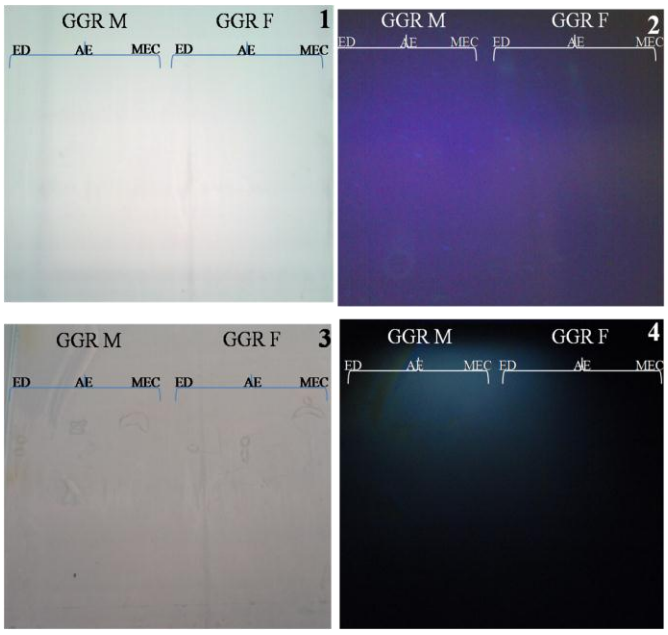
Fig. 3 Specters of phases in the Bolting stage

The results of the note that each plate has four photos.



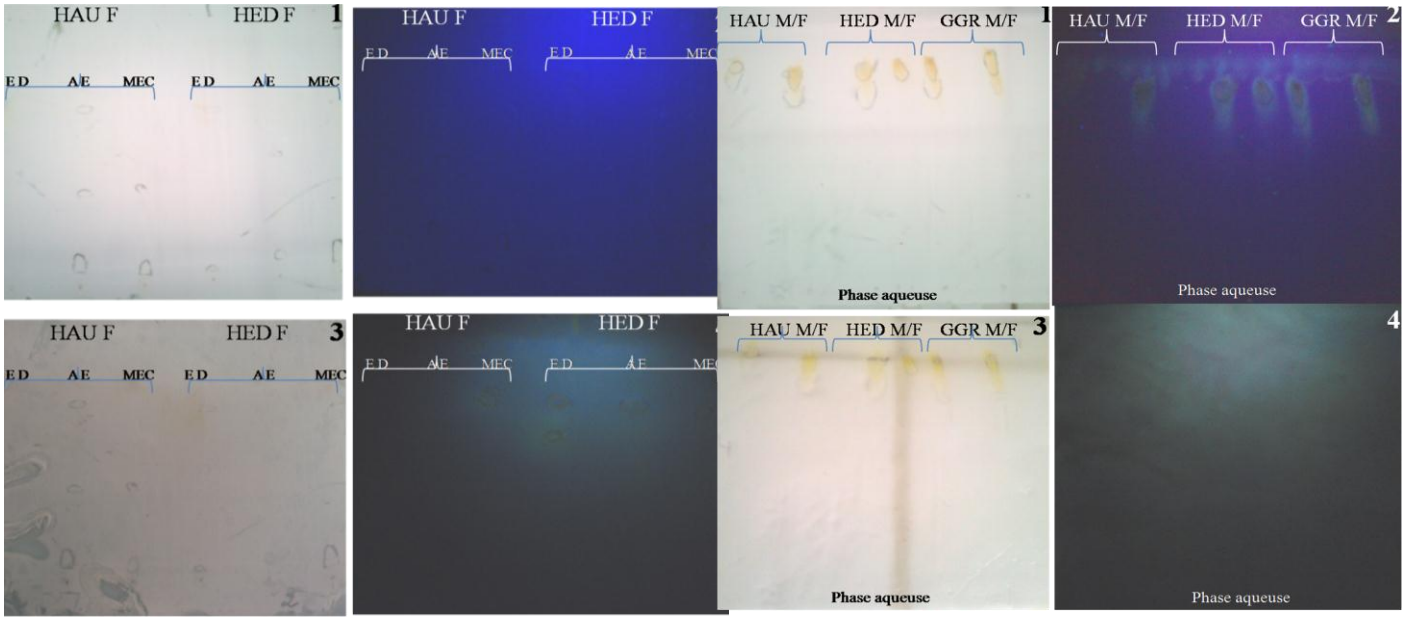
M: Bolting; F: Flowering stage; ED: Diethyl ether; AE: Ethyl Acetate; MEC: Methyl Ethyl Ketone.
1: Visible, 2: Under UV, 3: Visible after pulverisation with sulfuric acid 50%, 4: UV after pulverisation.

Fig. 4 TLC of the three varieties phases Haurani and Hedba, in Bolting stage, in the system Tol/ MEC/ EtOH/ EP (4/ 3/ 3/ 5)



M: Bolting; F: Flowering stage; ED: Diethyl ether; AE: Ethyl Acetate; MEC: Methyl Ethyl Ketone.
1: Visible, 2: Under UV, 3: Visible after pulverisation with sulfuric acid 50%, 4: UV after pulverisation.

Fig.6 TLC of the three varieties phases Haurani and Hedba, in bolting and flowering stages, in the system Tol/ MEC/ EtOH/ EP (4/ 3/ 3/ 5).



M: Bolting; F: Flowering stage; ED: Diethyl ether; AE: Ethyl Acetate; MEC: Methyl Ethyl Ketone.
1: Visible, 2: Under UV, 3: Visible after pulverisation with sulfuric acid 50%, 4: UV after pulverisation.

Fig. 5 TLC of Diethyl ether; Ethyl Acetate and Butanone of the GGR variety, in Bolting and Flowering stage, in the system Tol/ MEC/ EtOH/ EP (4/3/3/5).

M: Bolting; F: Flowering stage; ED: Diethyl ether; AE: Ethyl Acetate; MEC: Methyl Ethyl Ketone.
1: Visible, 2: Under UV, 3: Visible after pulverisation with sulfuric acid 50%, 4: UV after pulverisation.

Fig. 7 TLC of the aqueos phase of the three varieties in bolting and flowering stages, in the system 50/20/25: H2O distilled/n Butanol/EtOH.

TABLE III
THE FRONTAL REPORTS AND COLORS OF THE SPECKS IN THE TLC (BOLTING STAGE)

Variety	Phases	N° spots	RF	Colors
HAU	ED	2	0.53 0.65	Clear orange yellow
	AE	1	0.68	yellow
	MEC	1	0.69	Dark yellow
	H_2O	3	0.79 0.84 0.88	yellow orange Brown
HED	ED	1	0.65	Brown-black
	AE	1	0.61	Orange
	MEC	1	0.75	yellow
	H_2O	3	0.74 0.80 0.84	yellow orange Brown
GGR	ED	2	0.58 0.64	yellow orange
	AE	2	0.65 0.70	Greenish yellow Orange
	MEC	2	0.69 0.81	Orange yellow orange
	H_2O	3	0.76 0.85 0.91	yellow Orange brown

TABLE IV
THE FRONTAL REPORTS AND COLORS OF THE SPECKS IN THE TLC (FLOWERING STAGE)

	Phases	N° spots	RF	Colors
HAU	ED	1	0.5	Orange yellow
	AE	1	0.95	Clear bleu
	MEC	2	0.79 0.75	Purple orange
	H_2O	3	0.81 0.83 0.86	yellow Orange brown
HED	ED	2	0.65 0.77	Orange Purple
	AE	1	0.75	purple
	MEC	1	0.73	purple
	H_2O	3	0.79 0.83 0.87	yellow Orange brown
GGR	ED	1	0.75	Orange yellow
	AE	2	0.54 0.59	Clear yellow Orange
	MEC	3	0.72 0.75 0.79	Clear yellow Orange Clear brown
	H_2O	2	0.85 0.88	Orange brown

The number of compounds is almost the same. The diethyl ether phases showed one colorful spot in their majority which indicates that they are poor in flavonoids. Ethyl acetate and butanone phases have two spots for the majority. The aqueous phases are also rich in flavonoids which probably escaped during the separation of the precedent phases. Tables V and VI show the identification of the colored spots.

Therefore and according to Tables III and V, it can be assumed that the phases contain the following types of flavonoids (the numbers in Table VI are used in Table V to replace the types of flavonoids mentioned in the same line). It is observed that there are six groups of Phenolic compounds in the Bolting stage where there is only five in the flowering stage. The diethyl ether phase and the Butanone phase contain only four different groups. The ethyl acetate phase is the most rich in flavonoids because there are six groups of these compounds. There are no more than two groups of flavonoids for the aqueous phase. We can therefore conclude that the phases mainly contain Flavonols and flavones with different substitutions. Bolting stage phases are characterized by the presence of Flavonols and flavones with substitutions that do not exist in the flowering stage phases. Dihydroflavonols are exclusively present in the phase of ethyl acetate during the flowering stage.

TABLE V
RELATION BETWEEN FLUORESCENCE UNDER UV AND FLAVONOIDS STRUCTURE [13]

Spot Colored	Flavonoids type
1-Black-Brown	Flavonols 5, 6, 7 tris-OH free Flavonols 5, 7, 8 tris-OH
2-Brown black	3-OH absent or 3-OH substituted
3-Purple	Flavones 5-OH et 4'-OH Flavones 3-OR et 5-OH, 4'-OH Flavones ou Flavonols 5-OH avec 4'-OH absent or substituted in 3. Flavones 6- or 8-OH Chalcones, isoflavones, dihydroflavanols, flavanones.
4-Clear Bleu (fluorescent)	Flavones without 5-OH free Flavones without 5-OH free with 3-OH substituted
5-dull yellow, yellow, fluorescent orange	Flavonols 3-OH free with or without 5-OH substituted
6- bright yellow green	5-OH free or 5-OH substituted
7- fluorescent Yellow	Flavonols with 3-OH free
8-pale yellow	Dihydroflavonols

TABLE VI
THE FLAVONOIDS CONTAINED IN THE PHASES OF EACH STAGE.

Stage / Phases	Bolting	Flowering
Diethyl Ether	(2), (5) et (8)	(3) et (5)
Ethyl Acetate	(5), (6) et (7)	(3), (4) et (8)
Butanone	(5) et (7)	(1), (3) et (5)
H_2O	(1) et (5)	(1) et (5)

3. Antimicrobial activity

3.1 Antibacterial activity

We deduce that a compound has antibacterial activity Only if a zone of inhibition appears. The percentage of records where there is a formation of zones of inhibition is 77.77% .The inhibition zone diameters are different from one disk to another, depending on the variety and the bacterial strain. The averages of these diameters are shown in Fig 9.

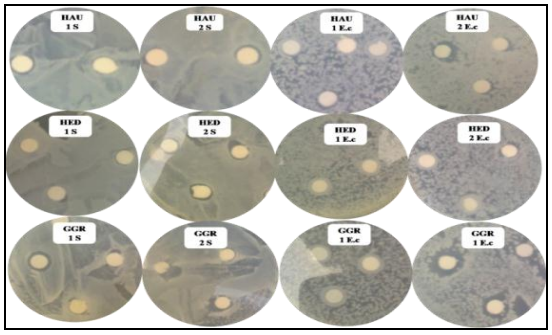


Fig. 8 Results of the effect of durum wheat extract on *E.coli* and *serratia.*

Haurani's extract has the strongest activity against the development and growth of *E. coli* with an average of diameter in the inhibition zones of 8.2 ± 0.09 mm followed by GGR's extract with an average of 4.5 ± 0.13 mm, and ultimately that of Hedba with a weaker effect than the extracts of the other varieties (4 ± 0.003 mm). In the other hand the *Serratia* proliferation is more inhibited by the ethanolic extracts of the varieties Hedba and GGR with an average of inhibition zones equal to11.2 ± 0.07 mm and 9.6 ± 0.15 mm successively, followed by Haurani (5 ± 0.04 mm) .The statistical analyze reveals no difference between the effect of extracts of the three varieties on both bacteria and shows that the extracts of the three varieties have the same inhibitory effect on both bacteria. The *E. coli* and *Serratia* sp have the same degree of inhibition. The SNK test regroups or the varieties or the bacteria under one group. The ethanolic extracts of Haurani, Hedba and GGR have an activity against the propagation of *E. coli* and *Serratia*. Based on quantification results, identification of phenolic compounds in the Maceras of these varieties and of this activity, the deduction that the phenolic compounds in durum wheat have antibacterial activity is evident.

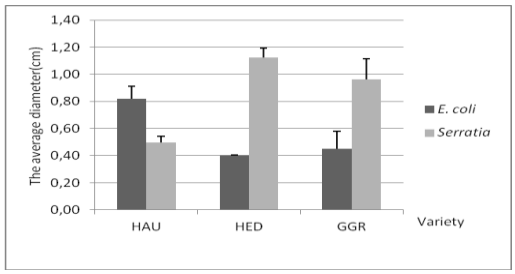


Fig. 9 Inhibition zones development of *E.coli* and *serratia* bacteria *with* the three varieties extract.

3.2. Antifungal Activity

Incubation of the plates containing fungus enables their development which is not total. This is due to the absence of mold in some areas, especially around the discs. We also note that there are some cases of infection (Fig 10).

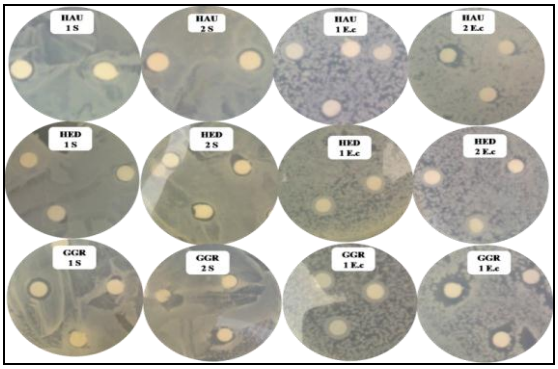


Fig. 10 Results of the antifungal activity.

The results show that the ethanolic extract of the three varieties of durum wheat has an inhibitory action on two molds: specie of the genus *Penicillium* and another from the genus *Rhizopus*. The antifungal activity is of course provided by the existing polyphenols of the alcoholic extract. Our results are consistent with those of Ortuno, [26] on two species Citrus.

It is clearly observed that the Haurani variety has a very powerful biological activity against *Penicillium* sp and *Rhizopus* sp molds. In the other part, the antifungal activity of Hedba is low and GGR is medium (Fig 11).

Haurani strongly inhibits the development of *Rhizopus* sp and have a less strong degree in the growth of *Penicillium* sp. Hedba and GGR exercise a considerable interruption against the spread of *Penicillium* sp but just a slight inhibition is marked against *Rhizopus* sp. The analysis of the ANOVA reveals that the difference between the antifungal activity performed on *Penicillium* sp and *Rhizopus* sp is significant. In addition, the SNK testshowed that the difference between the effect of the extract of Haurani and that of Hedba or GGR is highly significant for the first (HAU and HED) and highly significant for the second (HAU and GGR). Also, the difference between the effect of HED and GGR is not significant. Consequently, the HAU inhibitor effect is more powerful than that of HED and of GGR.

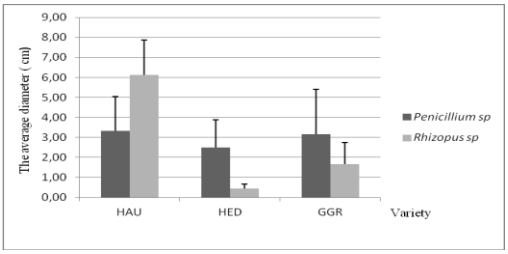


Fig. 11 The averages of the diameters of inhibition zones of each variety.

IV. CONCLUSION

Durum wheat Triticum durum Desf is widely used in food except that the consumed parts are fruits or seed. The vegetative mechanism, especially the aerial part is neglected and is given no importance. As our results show that it has remarkable nutritional and therapeutic values. In addition, the phytochemical study of the aerial part of three varieties (Haurani, Hedba and GGR) of this species during two phenological stages (flowering and Bolting) showed their richness in polyphenols. The quantitative study or the assay of total phenols indicates that each variety has major polyphenols content. According to the statistical analysis, this ratio is not significantly different in regards of the variety or of the stage, and varies between 6.13 and 11.92mg / g. After the separation of polyphenols by a series of ethanolic extracts clashes, the phase analysis by a UV-Visible spectrophotometry between 220 and 400 nm shows that the extracts of varieties are rich in simple phenols and phenolic acids and also of flavonoids.

The thin layer chromatography shows that Flavones and Flavonols are the most dominant flavonoids in this species. Tests of antimicrobial activity, specifically antibacterial and antifungal activity have given satisfactory results. The extracts of the three varieties have the same inhibitory effect on *E. coli* and *Serratia* sp, and both bacteria are inhibited identically. In contrast, the fungus *Penicillium* sp and *Rhizopus* sp both are affected by the antifungal property of the extracts in the same manner. Haurani compared to other varieties has a very powerful antifungal activity. Finally, instead of classifying durum wheat as a cereal or a purely food plant, it could direct its operation as a medicinal plant.

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