Journal of King Saud University – Science 31 (2019) 1175–1181

Contents lists available at ScienceDirect

Journal of King Saud University – Science

journal homepage: www.sciencedirect.com

Chemical composition and antioxidant activity of tannins extract from green rind of *Aloe vera* (L.) Burm. F.

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ARTICLE INFO

Article history:
Received 21 January 2018
Accepted 20 May 2018
Available online 21 May 2018

Keywords:
Aloe vera
GC/MS
Phytochemical screening
Tannins
Antioxidant activity
Histological identification

ABSTRACT

In the present study, we are interested in one of the most valuable medical plants, *Aloe vera*. It belongs to the family of xanthorroeaceae. This succulent plant possesses exceptional therapeutic virtues. For reasons principally related to its biological activities, *Aloe vera* has been traditionally used as a remedy for multiple diseases all over the globe. This study aims at characterization of tannins extract of *Aloe vera* (TAV) by gas chromatography coupled to mass spectrometry (GC/MS), phytochemical screening, morphological and histological identification of the species and extraction (tannins extract) from its green rind. The antioxidant activity of the tannins extract was tested using the 1.1-diphenyl-2-Picrylhydrazyl-Hydrate (DPPH) method. The results of the main constituents found were Palmitic acid (11.91%), E-Phytol (14.40%), Linolenic acid (16.59%), Diisooctylphtalate (11.84%). The tannins extract was also fractionated over a silica gel dry column. Three main fractions were isolated. The first fraction contains 25.99% of Palmitic acid, the second comprised Dibutyl phthalate (30.93%), and the third fraction showed an amount of 54.13% Diisooctylphtalate. The phytochemical screening showed the alkaloid, tannins, flavonoids, sterols, triterpenes, mucilages, oses, holosides and it reducing compounds metabolites, As for the coumarines and saponins, they were absent. The tannins extract showed an antiradical activity with percentage inhibition about 74.17% at 6 mg/ml.

1. Introduction

Many new antioxidants molecules have been secluded and determined from herbs and spices. The daily intake of these foods might be one of the major and promising sources against major disease leading to a healthier life. Biochemical results on edible plants wealthy in antioxidants are expected to lead to chemoprevention of lipid peroxidation, cancer, inflammation and aging of human organs (Nakatani, 2000). To consider a natural composite as an antioxidant substance, it is important to investigate its antioxidant activities in vitro.

Our study adopts this approach and it aims at showing the value of the tannin extracts from the green rind of *Aloe vera*.

Since a long time, *Aloe* has been used throughout history to treat some maladies, mainly those related to the digestive system; it has also been used for burns, skin troubles and wounds. The term *Aloes* refers to the dried juice, which streams from transversely cut bases of its leaves. It is the best home grown response that helps the body to be healthy and it also leads it to function optimally (Rajeswari et al., 2012).

Aloe vera (L.) Burm. F. (= *Aloe barbadensis Mill.*) is widely known as a medicinal plant, that belongs, according to the classification APGIII (2009) phylogenetics, to Xanthorrhoeaceae family and to the subfamily of Asphodelaceae. The *Aloe* comprises more than 180 species and hybrids native to sunny, arid areas in Southern and Eastern Africa, which was subsequently introduced into Northern Africa, Spain (Valencia and Granada), Gibraltar, China, and the

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jksus.2018.05.022
1018-3647/

West Indies (Haller, 1990). In Morocco, it was introduced at the beginning as an ornamental plant, but currently as a medicinal plant. The genus *Aloe* grows in arid zones, tropical and subtropical zones, that includes approximately 450 species. It is a succulent stemless or short-stemmed plant, which grows to 60–100 cm tall, spreads by offsets. Its leaves, which take a color from grey to green, are fleshy and very thick. Some of its varieties show white spots on the upper and lower surfaces of the stem and bitter yellow exudates birth by the perimetric bundle sheath cells. Each flower is pendulous with a yellow tubular corolla 2–3 cm long. Flowers are blossomed in the course of the summer session, on a spike up to 90 cm in height (Raksha et al., 2014).

Nowadays, *Aloe vera* plant is known for its use for several purposes in dermatology (Surjushe et al., 2008), *Aloe* is not only exploited in Homoeopathic, Ayurvedic and Allopathic streams of medicine, but it is also used by people in tribal community for medicine and food. The leaves of *Aloe vera* includes great vitamins, minerals, amino acids, natural sugars, enzymes and other benefits for health care due to bioactive compounds with emollient, purgative, antimicrobial, antinflammatory, aphrodisiac, antioxidant, antifungal and cosmetic values. *Aloe vera* principally proceeds as skin healer and prevents injury of epithelial tissues. Also proceeds as extremely powerful laxative, cures acne and gives a youthful glow to skin on the external use (Sahu et al., 2013). *Aloe vera* also possesses good antibacterial activity (Kumar et al., 2016). A recent report has shown that the aqueous extracts of *Aloe vera* collected from colder climatic regions are good antiplasmodial activity in comparison to those collected from warmer climatic sites (Kumar et al., 2017a). *Aloe vera* is also seen as a potential therapeutic source of bioactive phenol which has a good antioxidant activity (Kumar et al., 2017b,c).

This study aims at investigating for the first time the chemical composition of the tannins extract obtained from the green rind of *Aloe vera* and its fractions. The tannins extract and its fractions of *Aloe vera* were also used to evaluate the antioxidant potential of the plant.

2. Material and methods

2.1. Identification of the plant

After its morphological description, *Aloe vera* is identified by the histological aspect of the leaf using the double-stained: carmine-iodine green (Prat, 2004). This study was carried out on thin Hand-cute sections of *Aloe vera* leaves were treated with alum carmine for a few minutes, rinsed with distilled water until all the free carmine was removed, and then stained with iodine green for a few seconds. More precisely, this technique consists in staining the cell wall with iodine carmine-green: the pecto-cellulosic wall is colored pink and the lignified wall is colored blue-green. The anatomical sections are then mounted between the two slides in a drop of water and then they were observed under an optical microscope at different magnifications to determine the plant tissues that constitute those leaves. The observed cuts were subsequently photographed using a digital camera.

2.2. Plant material

Aloe vera, which grows under greenhouse in the GHARB region of Morocco (Rabat-Sale-Kenitra), was freshly harvested, washed and air dried for fifteen days at room temperature. Dried *Aloe vera* was powdered and stored prior to further use. It should be noted that a fresh quantity of *Aloe vera* was used for the determination of water content.

2.3. The water and dry matter contents

2.3.1. Technical

The water content is determined following the method of (Badreddine, 2016). 10 g of *Aloe vera* were freshly weighed and dried in an oven at 50 °C for 24 h. The dry matter was removed from the oven. After cooling in a desiccator, the dried sample was weighed.

2.3.2. Calculation

$$\text{Water content}(\%) = [(W_1 - W_2)/W_1] \times 100$$

W_1 stands for = Weight of the sample before drying; whereas W_2 = stands for Weight of the sample after drying.

Thus, dry matter content was extracted from water content as shown in the formula below:

$$\text{Dry matter content}(\%) = 100 - \text{Water content}(\%)$$

2.4. Phytochemical screening of plant material

Phytochemical constituents of *Aloe Vera leaves* were determined by different qualitative tests such as alkaloid (Dragendorff's), tannins (Ferric chloride test and stiasny reaction), anthraquinones, flavonoids (Magnesium and hydrochloric acid reduction), saponins (Foam index), triterpenes and sterols (Liebermann-burchard's test), oses and holosides (Alcohol saturated with thymol), mucilages (Alcohol 95% test), coumarins (UV-Lamp at 366 nm) and reducing compounds metabolites (Fehling's test) was performed by the following standard methods (Diallo, 2005; Raaman, 2006; and N'Guessan et al., 2009).

2.4.1. Alkaloids

In this test, we introduced powder (1 g) into a 50 ml of Erlenmeyer flask to which we added 5 ml of diluted H_2SO_4. This mixture was macerated for 24 h at room temperature. After that, One ml of the filtrate, a drop or two of Mayer's reagent, are added by the side of the test tube. A white or creamy precipitate indicates the test as positive.

2.4.2. Tannins

The search for catechetical tannins was carried out using Stiasny's reagent. We added 15 ml of Stiasny's reagent to the five ml of 5% infused and the mixture was kept in a water bath at 80 °C for 30 min. The observation of a precipitate in large flakes characterized catechic tannins.

For gallic tannins, we filtered the previous solution. The filtrate was collected and saturated with sodium acetate. The addition of 3 drops of $FeCl_3$ would cause the appearance of an intense blue-black color which is an indication of the presence of gallic tannins.

2.4.3. Flavonoids

After introducing into a test tube 5 ml of infused, we added 5 ml of hydrochloric alcohol, 1 ml of isoamyl alcohol and some magnesium chips. There was a crepitating reaction for a few minutes manifested by the appearance of a pink-orange (flavones), rose-purplish (flavanones), or red (flavonones, flavanonols) coloration. In contrast, by performing the cyanidine reaction without adding magnesium chips and without heating for 15 min in a water bath, in the presence of leucoanthocyane, a cherry or purplish red color.

2.4.4. Free anthraquinones

By introducing 1 ml of chloroform extract into a test tube in addition to 1 ml of diluted NH_4OH and stir the red color we came up with indicates the presence of free anthraquinones.

2.4.5. Combined anthraquinones

As for O-heterosides, we took 5 ml of hydrolyzate and we shook it with 5 ml of chloroform. After that, we withdrew the organic phase and we put it into a test tube. We added 1 ml of diluted NH_4OH. Agitate, the results show the presence of anthraquinones as indicated by an intense red color. In case the reaction is negative or weakly positive, one needs to look for reduced genin O-glycosides.

In addition to this, we Take took, first, 5 ml of hydrolyzate, we added 3–4 drops of $FeCl_3$ (10%), then, we heat the mixture for 5 min in a water bath. After that, we cooled and shook it with 5 ml of chloroform. Finally, we withdrew the chloroform phase before introducing it into a test tube by the addition of 1 ml of diluted NH_4OH and stir. In the case of a positive reaction, a red color that we came up with becomes more intense than before.

Going back to the aqueous phase, which has been preserved during the characterization of the O-heterosides with 10 ml of distilled water, we added 1 ml of $FeCl_3$ (10%). We held the test tube in a boiling water bath (boiled for 30 min), we cool and shake shook it with 5 ml of chloroform, we withdrew the chloroform phase in a test tube. We added 1 ml of diluted NH_4OH and stir. A more or less intense red color indicates the presence of genomes of C-glycosides

2.4.6. Sterols and triterpenes

We evaporated to dryness in a capsule 10 ml of ether extract dissolve the residue in 1 ml of acetic anhydride plus 1 ml of chloroform. We put them in two test tubes; one of the tubes will serve as a reference. Using a pipette, we put one to two ml of concentrated H_2SO_4 in the bottom of the test tube. At the zone of contact of the two liquids, a brownish or violet red ring was formed. The supernatant layer becomes green/violet which is indication about the presence of sterols and triterpenes.

2.4.7. Saponins

To search for the saponins, we poured 10 ml of the total aqueous extract into a test tube. The tube was stirred for 15 s. Then, it was left for 15 min. The results show that persistent foam height greater than 1 cm which indicates the presence of saponins.

2.4.8. Coumarines

We evaporated 5 ml of etheric extract (maceration for 24 h) in a capsule in the open air. We added 2 ml of hot water to the residue. We divided the solution between two tubes. After that, we added 0.5 ml of NH_4OH (25%) to the contents of one of the tubes. Next, we mixed everything, and we observed the fluorescence under UV-Lamp at 366 nm. Intense fluorescence in the tube where NH_4OH was added indicates the presence of coumarines. In this regard, the other tube serves as a control.

2.4.9. Mucilages

We introduced 1 ml of aqueous decoction (10%) in a test tube, and we added 5 ml of absolute alcohol with stirring. We waited for 10 min. The flaky precipitate indicates the presence of mucilages.

2.4.10. Oses and holosides

We introduced 5 ml of aqueous decoction (10%) into a capsule, and we evaporated it to dryness on a water bath. Next, we added 2–3 drops of concentrated H_2SO_4 to the residue. After 5 min, we added 3–4 drops of saturated alcohol with thymol. The development of a red color reveals the presence of oses and holosides.

2.4.11. Reducing compounds metabolites

We introduced 5 ml of aqueous decoction in a capsule, and we evaporated it in a water bath until it became dry. To the residue, we added 1 ml of Fehling reagent (0.5 ml of reagent A + 0.5 ml of reagent B, extemporaneous mixture). Thus, we obtained a red brick precipitate that indicates the presence of reducing compounds.

2.5. Extraction of the tannins from the green rind of Aloe vera (TAV)

The maceration process is carried out following, with some modifications, (Zhang et al., 2008) method. We took 10 g of the green rind of *Aloe vera*. The dried and crushed rind was extracted by 100 ml acetone-water (70/30, v/v) during 3 days at room temperature. The mixture was filtered and the acetone was removed by evaporation under vacuum at 40 °C. The remaining solution was washed with dichloromethane to eliminate the pigments and lipids. After that, the aqueous phase was extracted with ethyl acetate at a ratio of 1:1 (V/V). The layer of water was separated and it was analogously extracted twice. Then, the ethyl acetate phases (organic phase) which consist of tannins that were recovered and evaporated to 77 °C.

2.6. Fractionation by liquid chromatography (LC)

This Fractionation is studied using a classic chromatographic technique, which is a column on silica gel that allows us to achieve a separation of the tannins extract founded on its polarity. As a mode of elution, we chose hexane and hexane/acetate ethyl mixture of growing polarity (20%, 50%, 60% and 100% v/v hexane/ethyl acetate). In total, seven fractions were collected and compiled according to their profile on Thin-layer chromatography (TLC). The fractions (F_1–F_3) have been retuned as shown in Table 1.

2.7. Tannins extract analysis

The analyses process of the extract was carried out using Clarus SQ 8C GC/MS (Gas Chromatograph/Mass Spectrometer) PerkinElmer, company Tecnilab – HTDS France, equipped with a Rxi-5MS capillary column (30 m × 0.25 mm × 0.25 μm). Making some slight modifications, we adopted (Koutsoudaki et al., 2005) method. The oven temperature for the first 2 min was kept at 40 °C. Then, it was augmented at a rate of 4 °C/min until it reached 180 °C. Likewise, we augmented the temperature from 180 to 300 at a rate of 20 °C/min, and we kept it constant at 300 °C for 2 min. The injector temperature was also set at 220 °C split 1/20 of 1 μl was injected. The helium is the carrier gas with a flow rate of 1 ml/min. The condition of the mass spectrometer (200 °C for source temperature and 70 eV ionized potential). The chemical constituents of tannin extract were identified by their retentions indices (RI) and mass fragmentation patterns with those on the stored NIST library (version 2014).

2.8. DPPH free radical scavenging activity

The power of plant extracts to scavenge DPPH free radicals was specified on the basis of (Brand-Williams et al., 1995; Roby et al., 2013) methods. An aliquot of 0.1 ml of the TAV was mixed with 3.9 ml freshly prepared DPPH solution in a concentration of

Table 1
Mobile phases used for LC of the tannins extract.

Mobile phase	Relation	Volume (ml)	Fractions	Residue (g)
Hexane		200		
Hexane/Ethyl acetate	8:2	200	F_1	0.442
Hexane/Ethyl acetate	5:5	200		
Hexane/Ethyl acetate	4:6	200	F_2	0.614
Ethyl acetate		200	F_3	0.738

25 mg in 100 mL ethanol. After 30 min, the incubation of samples in darkness. The measured absorbance was made at 515 nm, with positive control (Ascorbic acid). The percentages of inhibition of the DPPH free radical, as a function of the impact extracts concentrations, were calculated using the equation: % Inhibition = $\left[\frac{A_{Control}-A_{Test}}{A_{Control}}\right] \times 100$ where, $A_{Control}$: absorbance of control; A_{Test}: absorbance of samples. The IC_{50} values indicate the concentration of samples that is needed to trap 50% of DPPH free radical. The IC_{50} was estimated by nonlinear regression via Excel, version 2013.

3. Results and discussion

3.1. Histological study of Aloe vera leaves

The microscopic structure of the *Aloe vera* leaf allowed us to distinguish:

- A superior epidermis and an inferior epidermis with a thick cuticle on the two external faces of the limbus and stomata;

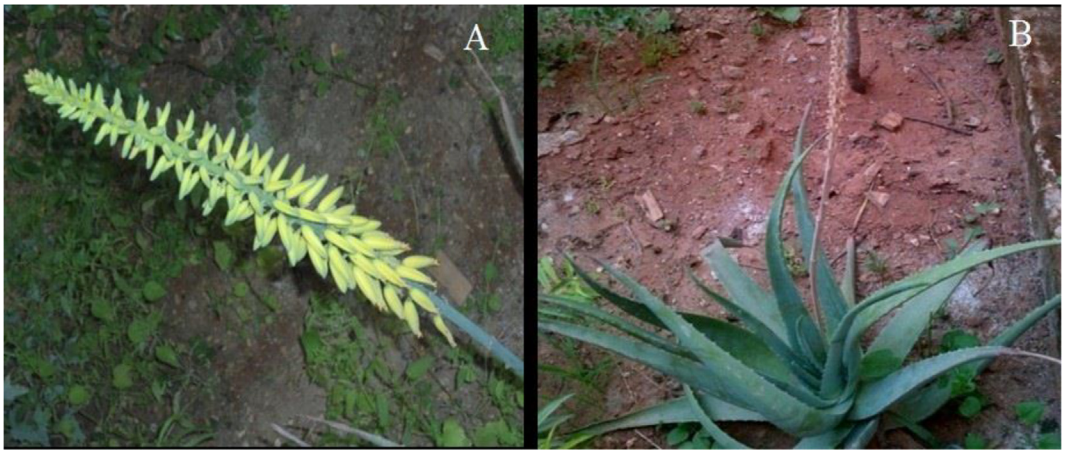

Fig. 1. (A) Inflorescences of *Aloe vera*; (B) Whole plant grown under glass.

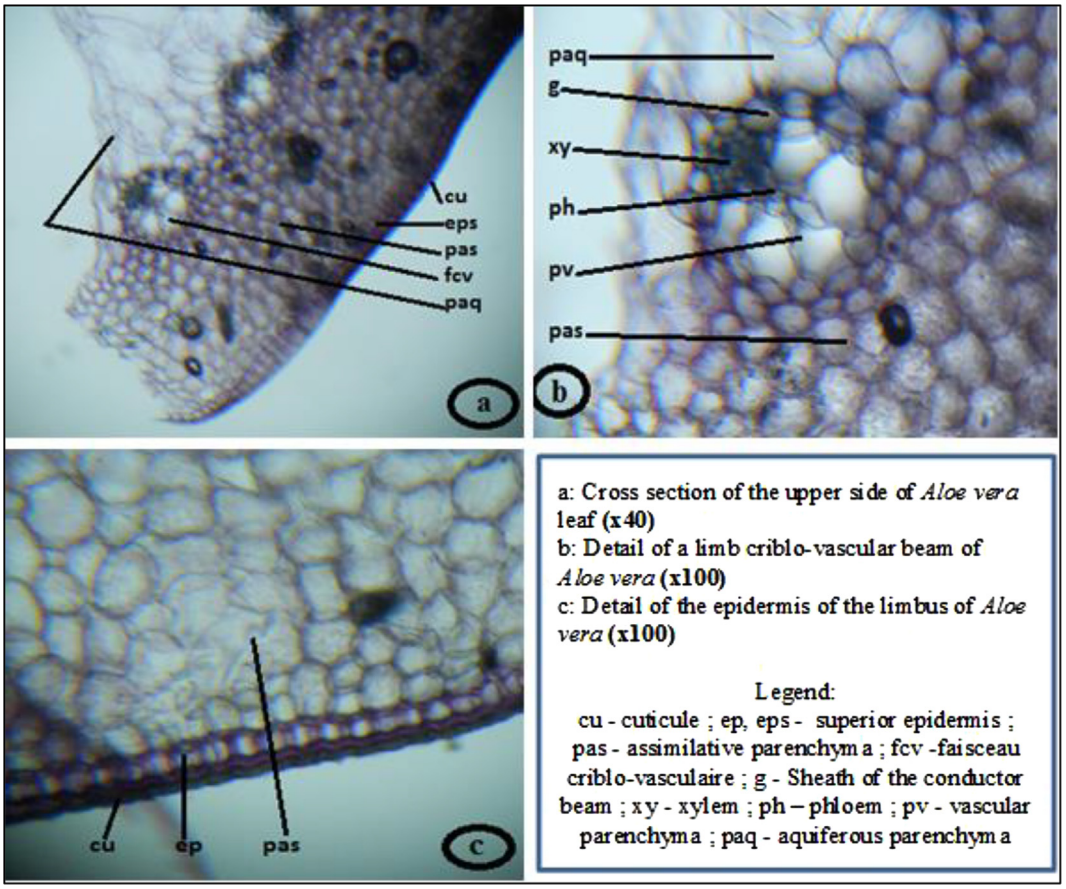

Fig. 2. Cross section of the upper side of the *Aloe Vera* Leaf.

- Towards the inside of the epidermis, an assimilative parenchyma formed of about 7–8 layers of chlorophyll cells, some of which contain crystals of calcium oxalate (site 1).
- An aquiferous parenchyma with hypertrophied cells, rich in mucilage (= hydrated gel) allowing the retention of the water, thus giving a succulence to the leaf which reduces the loss of water. This parenchyma occupies the central zone of the limbus and is devoid of crystals.
- In the contact zone between the two parenchyms, the ribs (= crib-vascular bundles) are located. Each conducting beam consists of xylem vessels, a few tubes of the phloem above which are found large cells with very thin wall corresponding to the vascular parenchyma and a cellulosic sheath surrounding the conductive beam.

The histological structure of the leaf of the sample at hand is compatible with that found in the literature related to *Aloe vera* (Morin., 2008) (Figs. 1 and 2).

3.2. The water and dry matter contents

For various reasons, a good determination of the moisture content is still an essential and important element for the analytical procedures. This determination of the total amount of water is of great benefit to product manufacturers since water is an inexpensive load. The dry matter that remains after the moisture analysis is called total solids (Nielsen., 2017).

As shown by Fig. 3 above, the contents of water and dry matter are 97% and 3% respectively. The results show that *Aloe vera* is rich in water because of its richness in mucilage which allows the retention of water.

Our results confirm that the *Aloe vera* plant leaf is composed primarily of water 97.4–99.5%, then go hand in hand with what other researchers such as (Ahmed and Hussain, 2013; Boudreau et al., 2013; Eshun and He., 2004) found.

3.3. Phytochemical screening

The phytochemical screening of the leaves of *Aloe vera* (Table 2) showed the presence of alkaloid, tannins, flavonoids, sterols, triterpenes, oses, holosides, mucilages and reducing compounds metabolites and the absence of saponins and coumarines. In this respect, our findings are in total agreement with those existing in the literature (Kumar et al., 2016; Raphael, 2012).

In relation to this, other studies have shown that the presence of saponins depends on extraction solvents. They are positive with ethanol, methanol, ethyl acetate, petroleum ether, acetone and hexane extracts and negative with the aqueous extract (Dharajiya et al., 2017; Tripathi et al., 2013).

It is noted that Aloe Vera plant is rich in secondary metabolites (known by their various biological effects) and in alkaloids which are distinguished by some health promoting properties such as anti-inflammatory, antimalarial, antimicrobial, cytotoxicity,

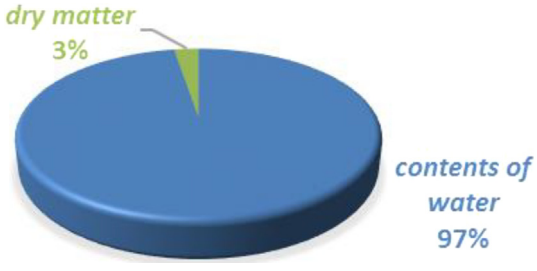

Fig. 3. The water and dry matter contents.

Table 2
Results of the phytochemical screening of *Aloe vera* leaves.

Phytochemical tests			*Aloe vera*
Alkaloides			++
Tannins	Catechic		++
	Gallic		−−−
Anthraquinones	Free		−−−
	Combined	O-heterosides	−−−
		Reduced Genins	+++
		C-heterosides	+++
Flavonoids	Flavones		+++
	Leucoanthocyanins		+++
Saponins			−−−
Sterols and Triterpenes			+ + +
Oses and holosides			++
Mucilages			+ + +
Coumarines			−−−
Reducing compounds metabolites			++

+++, High concentration; ++, moderate concentration; +, low concentration; −−−, absence.

antispasmodic and pharmacological effects (Iqbal et al., 2018). Tannins have a biological and pharmacological activity which includes antioxidative, antibacterial, antiviral, cardioprotective, antitumor, anti-inflammatory and immune-modulatory (Kumari and Jain, 2012). As for Flavonoids, they exhibit many pharmacological activities such as antioxidants, anti-allergic, anti-inflammatory, antimicrobial and anticancer properties (Khanam et al., 2015).

3.4. Extraction yield of TAV

$$R = \frac{m_2}{m_1} = \frac{0.149}{10} \times 100 = 1.49\%$$

with: m_1 = Mass of green rind of *Aloe vera* starting and m_2 = Mass of tannins extract.

3.5. Chemical composition of the tannins extract

The GC/MS analysis of the extract was done: Nine compounds, accounting for 72.81% of the TAV, as well as 14 compounds representing 93.55% of F_1, 8 compounds representing 79.82% of F_2 and 89.63% of 7 compounds from F_3. The Quantitative and the qualitative analytical results are illustrated in Table 3.

The TAV showed that the major constituents were Linolenic acid (16.59%), Phytol (14.40%), Palmitic acid (11.91%), and Diisooctyl phtalate (11.84%) whereas the major constituents of the first fraction contained Palmitic acid (25.99%), Dibutyl phthalate (17.97%), and Linoleic acid (11.71%). In addition, the second fraction contained the most dominant compounds. It consisted respectively of Dibutyl phthalate (30.93%), Butyl cyclobutyl phthalate (11.61%) and Phthalic acid, and butyl 2-pentyl ester (11.10%). The principal common constituents of the third fraction were Diisooctylphtalate (54.13%) and 9-Heptadecanone (11.35%). The results show that the F_1 is rich in fatty acid 9-Oxononanoic acid (2.27%), Palmitic acid (25.99%), 17-Octadecynoic acid (3.80%), Linoleic acid (11.71%) with a percentage of 44.77%, and the TAV extract Palmitic acid (11.91%), 17-Octadecynoic acid (6.20%), Linolenic acid (16.59%), Chrysophanic Acid (3.82%) with a percentage of 38.52%. However, this does not extend to the F_2 and F_3. It should be noted that the presence of Phytol (14.40%) in considerable contents in TAV, the alcoholic diterpenoid is particularly interesting due to its diverse activities (Costa et al., 2016).

In the present study, we might be, to our knowledge, the first to tackle/consider the chemical composition of the tannins extract

Table 3
Chemical composition of the tannins extract of *Aloe vera*.

N°	Retention time	Compounds	Area %			
			TAV	F_1	F_2	F_3
1	5.40	Butanoic acid	0.72	1.73	–	–
2	5.58	Hexanal	–	2.01	–	–
3	6.79	Pyranton	2.53	–	–	–
4	28.71	9-Oxononanoic acid	–	2.27	–	–
5	38.55	Diisobutyl phthalate	–	2.78	5.89	
6	38.61	9-Heptadecanone	–	–	–	11.35
7	39.12	Butyl cyclobutyl phthalate	–	5.43	11.61	2.87
8	39.34	Butyl isobutyl phthalate	–	2.35	4.73	–
9	39.56	Palmitic acid	11.91	25.99	–	–
10	39.60	Dibutyl phthalate	–	17.97	30.93	7.80
11	39.79	Phthalic acid, butyl 2-pentyl ester	–	6.87	11.10	5.22
12	39.85	Ethyl palmitate	–	–	–	4.52
13	40.08	Phthalic acid, butyl-3-methyl butyl ester	–	1.95	3.93	–
14	40.40	Butyl decyl phthalate	–	4.37	6.97	–
15	40.50	Butyl octyl phthalate	–	–	4.66	–
16	40.76	Phytol	14.40	–	–	–
17	40.89	17-Octadecynoic acid	6.20	3.80	–	–
18	40.93	Linoleic acid	–	11.71	–	–
19	40.94	Linolenic acid	16.59		–	–
20	41.05	Butyl palmitate	–	4.32	–	–
21	41.24	Ethyl octadecanoate	–	–	–	3.74
22	42.06	Chrysarobin	4.80	–	–	–
23	42.20	Chrysophanic Acid	3.82	–	–	–
24	42.98	Diisooctylphtalate	11.84	–	–	54.13
		Total identifed	72.81	93.55	79.82	89.63

(–): Means trace state.

obtained from the green rind of *Aloe vera* and its fractions. Additionally, scarce are the studies in the literature that focus on the chemical composition of *Aloe vera* extracts by GC/MS analysis. The chemical composition of aqueous extract show that the major constituents are n-hexadecanoic acid (20.41), oleic acid (14.49), 1,2-benzenedicarboxylic acid, diisooctyl ester (13.56), Octacosane (9.52), Hentriacontane (8.14) and squalene (6.57) (Saljooghianpour and Javaran., 2013). Another study of hexane extract shows that the principal common constituents are n-hexadecanoic acid (20.47), oleic acid (14.53), hexadecanoic acid, 1,2-benzenedicarboxylic acid, diisooctyl ester (13.60), Octacosane (9.56), Hentriacontane (8.18) and squalene (6.60) (Lakshmi and Rajalakshmi, 2011).

It is obvious that three compounds are predominant: n-hexadecanoic acid, oleic acid and hexadecanoic acid 1,2-benzenedicarboxylic acid, diisooctyl ester in the hexane extracts and aqueous. However, the tannin extract shows a predominance of Linolenic acid and Phytol compounds, as well as the Palmitic acid (n-hexadecanoic acid), Diisooctyl phtalate (1,2-benzenedicarboxylic acid, diisooctyl ester), with a weak percentage that compared to the first two extracts (hexane and aqueous). These differences in composition observed among the extracts can be attributed to the geographical origin, the environmental conditions the solvent and the extraction method used.

3.6. Antioxidant activity of the tannins extract of Aloe vera

The antioxidant activity of tannins extract, from green rind of *Aloe vera* is determined by the free radical DPPH reduction method (Fig. 4).

The antioxidant capacity has been given from the IC_{50} (Table 4). It is the concentration of the antioxidant giving 50% inhibition of DPPH in the test solution. The evaluation of the antioxidant capacity of the TAV and its fractions (F_1, F_2 and F_3), show that the IC_{50} values are 1.9, 3.74, 5.55 and 2.8 mg/ml respectively. This activity is lower than that of ascorbic acid which show an IC_{50} of 0.047 mg/ml. TAV and F_1 which are richer in fatty acid show the most important antioxidant power. The high antioxidant activity detected in TAV may be due to some major compounds in particular such as phytol and Palmitic acids that are known for their

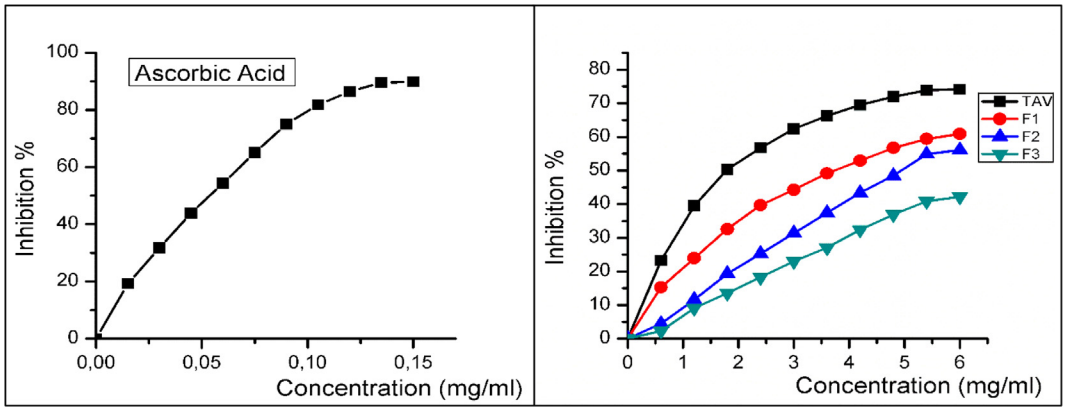

Fig. 4. DPPH radical scavenging activity of ascorbic acid, TAV, F_1, F_2 and F_3.

Table 4
IC_{50} concentration of DPPH scavenging capacity from bioactive compounds.

Bioactive compounds	IC_{50} (mg/mL)
TAV	1.85
F_1	3.70
F_2	5.51
F_3	11.04
Ascorbic acid	0.05

various biological activities. The Phytol is known as antioxidant, antimicrobial, anticancer, anti-inflammatory, and diuretic (Islam et al., 2015; Costa et al., 2016). As for the Palmitic acid is known as antioxidant, hypocholesterolemic nematicide, pesticide, anti-androgenic, hemolytic, and 5-Alpha reductase inhibitor (Lakshmi and Rajalakshmi, 2011; Kumar et al., 2010).

4. Conclusion

In this work, we have focused on the study of the antioxidant activity of the tannins extract obtained from the green rind of *Aloe vera*. After having identified the plant, we have been able to deduct that the transverse cut made for *Aloe vera* is compatible with the one described in the literature. According to the phytochemical tests, we have found that the *Aloe vera* is rich of alkaloids, tannins, flavonoids, sterols, triterpenes, oses, holosides, mucilages and reducing compounds metabolites whereas the saponins and coumarines were absent. The result of the main constituents of the TAV were: Palmitic acid (11.91%), Phytol (14.40%), Linolenic acid (16.59%), Diisooctylphtalate (11.84%). The in vitro antioxidant activity showed that the tannins extract of *Aloe vera* has a moderate antiradical activity.

References

Ahmed, M., Hussain, F., 2013. Chemical composition and biochemical activity of *Aloe vera (Aloe barbadensis* Miller) leaves. IJCBS 3, 29–33.

Badreddine, A. Préparation et Caractérisation d'extraits d'Argania Spinosa et d'huile d'argan et Evaluation de Leurs Effets Neuroprotecteurs In Vivo et In Vitro. Ph.D. Thesis, Université de Bourgogne, Dijon, France; Université Hassan 1er, Settat, Morocco, 2016, p100.

Boudreau, M.D., Mellick, P.W., Olson, G.R., Felton, R.P., Thorn, B.T., Beland, F.A., 2013. Clear evidence of carcinogenic activity by a whole-leaf extract of *Aloe barbadensis* miller (*aloe vera*) in F344/N rats. Toxicol. Sci. 131, 26–39.

Brand-Williams, W., Cuvelier, M.E., Berset, C., 1995. Use of a free radical method to evaluate antioxidant activity. Food Sci. Technol. 28, 25–30.

Costa, J.P., Islam, M.T., Santos, P.S., Ferreira, P.B., Oliveira, G.L.S., Alencar, M.V., Paz, M.F., Ferreira, É.L., Feitosa, C.M., Citó, A.M., Sousa, D.P., Melo-Cavalcante, A.A., 2016. Evaluation of antioxidant activity of phytol using non-and pre-clinical models. Curr. Pharm. Biotechnol. 17, 1278–1284.

Dharajiya, D., Pagi, N., Jasani, H., Patel, P., 2017. Antimicrobial Activity and Phytochemical Screening of *Aloe vera (Aloe barbadensis* Miller). Int. J. Curr. Microbiol. Appl. Sci. 6 (3), 2152–2162.

Diallo, A., 2005. Etude de la phytochimie et des activités biologique de *Syzygium guineense*. willd. (myrtaceae). PhD. of the University Bamako, Mali, pp. 38–47.

Eshun, K., He, Q., 2004. Aloe Vera: a valuable ingredient for the food, pharmaceutical and cosmetic industries-a review. Crit. Rev. Food Sci. Nutr. 44, 91–96.

Haller, J.S., 1990. A drug for all seasons. Medical and pharmacological history of *aloe*. Bull. N.Y. Acad. Med. 66 (6), 647–659.

Iqbal, E., Lim, L.B.L., Salim, K.A., Faizi, S., Ahmed, A., Mohamed, A.J., 2018. Isolation and characterization of aristolactam alkaloids from the stem bark of *Goniothalamus velutinus* (Airy Shaw) and their biological activities. J. King Saud Univ. Sci. 30, 41–48.

Islam, M.T., De Alencar, M.V.O.B., Da Conceição Machado, K., Da Conceição Machado, K., De Carvalho Melo-Cavalcante, A.A., De Sousa, D.P., De Freitas, R.M., 2015. Phytol in a pharma-medico-stance. Chem. Biol. Interact. 240, 60–73.

Khanam, Z., Wen, C.S., Bhat, I.U.H., 2015. Phytochemical screening and antimicrobial activity of root and stem extracts of wild *Eurycoma longifolia* Jack (Tongkat Ali). J. King Saud Univ. Sci. 27, 23–30.

Koutsoudaki, C., Krsek, M., Rodger, A., 2005. Chemical composition and antibacterial activity of the essential oil and the gum of *Pistacia lentiscus* Var. chia. J. Agric. Food Chem. 53, 7681–7685.

Kumar, S., Budhwar, L., Yadav, A., Yadav, M., Yadav, J.P., 2016. Phytochemical screening and antibacterial activity of *Aloe vera* collected from different climatic regions of India. Nat. Prod. J. 6 (1), 73–82.

Kumar, P., Kumaravel, S., Lalitha, C., 2010. Screening of antioxidant activity, total phenolics and GC-MS study of *Vitex negundo*. Afr. J. Biochem. Res. 4, 191–195.

Kumar, S., Yadav, M., Yadav, A., Yadav, J.P., 2017b. Impact of spatial and climatic conditions on phytochemical diversity and in vitro antioxidant activity of Indian *Aloe vera* (L.) Burm.f. S. Afr. J. Bot. 111, 50–59.

Kumar, S., Yadav, A., Yadav, M., Yadav, J.P., 2017c. Effect of climate change on phytochemical diversity, total phenolic content and in vitro antioxidant activity of *Aloe vera* (L.) Burm.f. BMC. Res. Notes 10 (1), 1–12.

Kumar, S., Yadav, M., Yadav, A., Rohilla, P., Yadav, J.P., 2017a. Antiplasmodial potential and quantification of aloin and aloe-emodin in *Aloe vera* collected from different climatic regions of India. BMC Complement. Altern. Med. 17 (1), 1–10.

Kumari, M., Jain, S., 2012. Tannins: an antinutrient with positive effect to manage diabetes. Res. J. Recent Sci 1, 1–8.

Lakshmi, P.T.V, Rajalakshmi, P., 2011. Issn 2230 – 8407 Identification of Phyto-Components and Its Biological Activities of Aloe Vera Through the Gas Chromatography-Mass Spectrometry, 2, pp. 247–249.

Morin, E., 2008. In: *Aloe vera* (L) Burm .F: Aspects Pharmacologiques et Cliniques. Ph D of the University Nantes, France, pp. 44–46.

N'Guessan, K., Kadja, B., Zirihi, G., Traoré, D., Aké-Assi, L., 2009. Screening phytochimique de quelques plantes médicinales ivoiriennes utilisées en pays Krobou (Agboville, Côte-d'Ivoire). Sci. Nat. 6 (1), 1–15.

Nakatani, N., 2000. Phenolic antioxidants from herbs and spices. Biofactors 13 (1–4), 141–146.

Nielsen, S.S., 2017. In: Food Analysis. fifth ed. Springer, New York, pp. 259–260.

Prat, R., 2004. In: Expérimentation en biologie et physiologie végétales. Editions Quae & Hermann, p. 303.

Raaman, N., 2006. In: Phytochemical Techniques. New India Publishing Agency, New Delhi, pp. 19–24.

Rajeswari, R., Umadevi, M., Rahale, C.S., Pushpa, R., Selvavenkadesh, S., Kumar, K.P. S., Bhowmik, D., 2012. *Aloe vera*: The Miracle Plant Its Medicinal and Traditional Uses in India. J. Pharmacogn. Phytochem. 1 (4), 118–124.

Raksha, B., Pooja, S., Babu, S., 2014. Bioactive compounds and medicinal properties of *Aloe vera L.* an update. J. Plant. Sci. 2 (3), 102–107.

Raphael, E., 2012. Phytochemical constituents of some leaves extract of *Aloe vera* and *Azadirachta indica* plant species. Glob. Adv. Res. J. Environ. Sci. Toxicol. 1 (2), 14–17.

Roby, M.H.H., Sarhan, M.A., Selim, K.A.H., Khalel, K.I., 2013. Evaluation of antioxidant activity, total phenols and phenolic compounds in thyme (*Thymus vulgaris* L.), sage (*Salvia officinalis* L.), and marjoram (*Origanum majorana* L.) extracts. Ind. Crops Prod. 43 (1), 827–831.

Sahu, P.K., Giri, D.D., Singh, R., Pandey, P., Gupta, S., Shrivastava, A.K., Kumar, A., Pandey, K.D., 2013. Therapeutic and medicinal uses of *Aloe vera*: a review. Pharmacol. Pharm. 4 (8), 599–610.

Saljooghianpour, M., Javaran, T.A., 2013. African Journal of Biotechnology Identification of phytochemical components of aloe plantlets by gas chromatography-mass spectrometry. 12, pp. 6876–6880.

Surjushe, A., Vasani, R., Saple, D.G., 2008. *Aloe vera*: a short review. Indian J. Dermatol. 53, 163–166.

Tripathi, A., John, S.A., Rao, K.P., Ramteke, P.W., 2013. Comparative study on phytochemical constituents, antimicrobial and plasmid curing property of *Aloe vera* and *Ocimum sanctum*. J. Ecophysiol. Occup. Health 4, 1–6.

Zhang, S.Y., Zheng, C.G., Yan, X.Y., Tian, W.X., 2008. Low concentration of condensed tannins from catechu significantly inhibits fatty acid synthase and growth of MCF-7 cells. Biochem. Biophys. Res. Commun. 371, 654–658.