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C/EBPA AS A BIOMARKER GENE IN CANCER CELL AND ITS RELATION TO NATURAL ANTICANCER COMPOUNDS

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Abstract

Leukemia is a rapidly progressive disease which is one of the most common causes of death worldwide. Several therapy modalities have been employed in the treatment of leukemia such as natural anticancer compounds which found in plants e.g. Saussurea Lappa (S. lappa). To determine cytotoxic activity of S. lappa extracts in relation to CCAAT/Enhancer Binding Protein Alpha (C/EBPA) gene expression, in addition to phytochemical analysis and antioxidant activity. Successive extraction of S. lappa root powder using methanol, ethanol, acetone, ethyl acetate and chloroform solvents with separation of twelve fractions from chloroform extract by thin layer chromatography (TLC). Estimation of total phenolic and total flavonoid were done together with antioxidant, cytotoxic activity of S. lappa extracts which has been tested on three leukemia cell cultures by MTT assay. C/EBPA gene expression was detected by quantitative real time PCR (qRT-PCR). The chloroform extract of S. lappa showed the highest cytotoxic activity against three cancer cell cultures. Regarding C/EBPA gene expression in leukemic cells after addition of chloroform fractions (C2+C9) from the S. lappa plant, we found a statistically significant difference (P value 0.008) with (C9) compound; this denotes the higher cytotoxic activity of (C9) on the leukemia cells. The S. lappa roots contain phenol and flavonoid compounds, which have a high cytotoxic effect on leukemic cells and improve CEBPA gene expression which is a known good prognostic marker. Further studies of S. lappa for the elucidation of the cytotoxic mechanisms considered as immense importance to deal with leukemia.

Key words: Saussurea lappa, phytochemical analysis, antioxidant, cytotoxic activity, CEBPA gene.

Introduction

Cancer is considered the major cause of death worldwide. The prevalence of cancer has actually increased where cancer cells are basically transformed from normal cells which require various genetic mutations (Siegel et al., 2013). One type of cancer is leukemia which is hematological malignancy and has four subtypes: acute myeloid leukemia (AML), acute lymphoblastic leukemia (ALL), chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML) (Tubergen et al., 1993). Leukemia is more common among developed countries and higher socioeconomic groups (Gholami et al., 2011). The etiology of leukemia is obscure. Previous studies suggested that genetic, environmental, and occupational factors may contribute to the etiology in some patients and certain populations (Jabbour et al., 2006).

Medicinal plants are used for healing purposes throughout the human history; even in the current era, there are up to 80% of the world population especially the developing countries rely on traditional herbal medicine as a system of health care. Many herbal medicines which prescribed in traditional medicine lacked knowledge and accurate scientific methods (Ekor 2013). Saussurea lappa one of those plants it also known as Saussurea costus, kuth root or costus. It belongs to Asteraceae family; which includes about 1000 genera and 30,000 species widely distributed in different regions in the world. However, numerous species are found in India and Pakistan and some parts of Himalayas (Pandey et al., 2007 & Shah et al., 2006). S. lappa has been used in traditional medicine for the treatment of several ailments and diseases such as asthma, certain bronchitis, ulcer,
stimulant, antiseptic, carminative, sedative, bronchodilator, astringent agent and stomach problems since ancient times (Chhabra et al., 1998, Lee et al., 1986 and Kim et al., 2001). S. lappa has a good cytotoxic activity against cancer (Robinson et al., 2008); In addition, several investigations showed other bioactive properties of S. lappa roots such as anti-inflammatory, hepatoprotective, immunomodulator, hypoglycemic, spasmylytic, anticonvulsant, anti diarrheal and antiviral activity (Zahra et al., 2014 & Ghasham et al., 2017).

The main active compounds of S. lappa reported as antioxidant compounds are costunolide, dehydrocostus lactone, in addition to some fatty acids such as palmitic, linoleic acids. Also, β-sitosterol, alantolactone and isoalantolactone isolated from S. lappa are reported to have medicinal properties (Nandagoapalan et al., 2016).

CCAAT/Enhancer Binding Protein Alpha (C/EBPA) is the myeloid specific transcription factor that can regulate the balance between cell proliferation and differentiation in hematopoietic and non-hematopoietic tissues (McKnight et al., 2001). C/EBPA is mapped to intronless gene on human chromosome 19q13.1. It is belongs to the basic region of leucine zipper (bZIP) class of DNA-binding proteins (Fuchs et al., 2007). C/EBPA plays a major role during the commitment of hematopoietic stem cells towards granulocytic and monocytic differentiation (Dahl et al., 2003). C/EBPA mutations have been observed in AML patients with the approximate frequency of 5-14% (Shih et al., 2005; Sollip Kim et al., 2012).

The purpose of this work to determine the total phenols, total flavonoids of different S. lappa root extracts jointly with antioxidant and cytotoxic activities on leukemic cell culture and their relation to C/EBPA gene expression on acute myeloid leukemia cells.

**Clinical significance**

Phenolic and flavonoid compounds are widely distributed in plants, which have received considerable attention because of its potential antioxidant and cytotoxic activities for human health care. Estimation of total phenolic and total flavonoid were done together with antioxidant, cytotoxic activity of S. lappa extracts which has been tested on three leukemia cell cultures by MTT assay. C/EBPA gene expression was detected by quantitative real time PCR (qRT-PCR).

**Material and Methods**

**Plant extracts preparation**

The plant materials were collected from local market in Cairo, Egypt and authenticated by El-Orman garden at the taxonomy and flora section. Powdered black root of S. lappa (40 g) was extracted successively with 70 ml of chloroform, ethyl acetate, acetone, ethanol and methanol. The extract filtrated by filter papers then evaporated to dryness under reduced pressure by rotary evaporator. The obtained extracts were stored in light-protected brown bottle at -20°C until further use.

**Phytochemical screening**

**Determination of total phenolic content**

The amount of total phenolic of the different tested S. lappa extracts was determined with the Folin-Ciocalteau reagent (Singleton, 1999). Each sample (50 µl) was added to 2.5 ml diluted Folin-Ciocalteau’s reagent (1/100) and 2 ml of Na₂CO₃ (7.5%, w/v) then incubated at 45°C for 15 min. The absorbance of all samples was measured at 765 nm by UV-Vis Spectrophotometry. Gallic acid standards were prepared from 0 to 100 µg, the plot of standard curve was done by using various concentrations of Gallic acid then the results were expressed as Gallic acid equivalent (GAE).

**Determination of total flavonoid content**

The total flavonoid content was estimated using the Dowd method (Meda, 2005). Briefly, Aluminum trichloride (1 ml 2 %) in methanol was mixed with the same volume of the extract. Mixture was left for 10 min. at room temperature then absorbance was measured at 415 nm. The total flavonoid content was determined using a standard curve with quercetin with concentrations from 0 to 100 µg/l. The total flavonoid was determined as µg of quercetin equivalents (QE)/100 g of S. lappa extracts.

**Antioxidant activity**

**Determination of scaveneging activity**

Different concentrations (200, 400, 600, 800 and 1000 ppm) of different S. lappa extracts were used. Synthetic antioxidant (BHT, butylated hydroxytoluene) was used as a positive control. Each plant extract (1ml) and positive control was mixed with 1ml DPPH (2,2-diphenyl-1-picrylhydrazyl) reagent [0.002%(w/v)/ methanol solution]. After incubation for 30 min in the dark at room temperature, the absorbance was measured at 517 nm. The radical-scavenging activity was expressed as percentage of inhibition and calculated using the following formula: % inhibition = [(A control – A sample) / (A control)] × 100 (Blois, 1958).

**Determination of reducing power**

The reducing power was determined using different concentrations (200, 400, 600, 800 and 1000 ppm) of S. lappa extracts (Oyaizu, 1986). Gallic acid was used as standard. A volume of 200 µL of each extract as well as the standard at different concentrations were taken separately and mixed with 500 µL of 0.2 mol/L phosphate buffer (pH 6.6) and 500 µL of potassium ferricyanide. The samples were incubated at 50°C for 20 min. Then 500 µL of 10% trichloroacetic acid were added and
centrifuged at 6500 r/min for 16 min. About 700 µL of supernatant was taken and added to 700 µL distilled water and 140 µL of freshly prepared ferric chloride, then left to stand for 10 min at room temperature. Finally, the absorbance was measured at 700 nm. A standard curve for gallic acid was generated and the linear equation was used to calculate the reducing power of each extract as a gallic acid equivalent.

**Leukemic cells separation and Trypan blue assay**

EDTA peripheral blood samples from AML, ALL and CML patients were obtained from Kasr Al-Ainy Center of Radiation Oncology and Nuclear Medicine, Cairo University hospitals, Egypt. Briefly, one volume of peripheral blood was added to one volume of phosphate buffer saline (pH 7 PBS). Then, two volumes of ficoll reagent was added to the previous mixture. Separation of buffy coat was done by centrifugation for 30 min at 1600 rpm and final cell suspension was made by adding 1 ml PBS. For each examined sample, a new clean, dry test tube was used and 10 µL of cell suspension, 80 µL saline and 10 µL trypan blue (0.4%) were added and mixed (Bennett et al., 1976). Then the number of living cells (non-stained) was calculated using a hemocytometer slide by inverted microscope (Olympus IX70, Japan). Using the following equation No. of cells/ml = dilution factor × 10^4 × mean of number of cell/square.

**Cytotoxic activity using MTT Assay**

The culture medium was prepared using RPMI 1640 media with sodium carbonate and L-glutamine (Lonza, Verviers, Belgium), 10% of fetal bovine serum (Eurolone, Italy, Europe), 100 units/ml penicillin and 100 mg/ml streptomycin were added. The anticancer effect of the different five extracts on Leukemic cell culture was determined by the MTT (3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide) assay (Denizot et al., 1986). Five thousand cells per well (20 µl) from AML, ALL and CML patients and normal white blood cells (WBCs) were plated in 96-well plates in the presence of various concentrations of the extracts (100, 200 and 300 ppm) and endoxan as positive control with the same concentrations for 24 h at 37°C in 5% CO2 incubator. Then the media was removed and the plate was incubated for 4 h in the presence of 0.5 mg/ml of MTT. Absorbance that reflects the viable cell number and was measured at 570 nm. % Cell death was calculated using the following formulas % Cell death = (Control OD – Sample OD)/Control OD × 100.

**Thin layer chromatography (TLC) fractionation of the chloroform extract of S. lappa**

The chloroform extract of *S. lappa* gave the highest
cytotoxic activity so it was fractionated using TLC technique. Garg and Sharma, (2016) The extract was applied on silica gel 60 F254 TLC aluminum sheets (20 x 20) (Merck, Darmstadt, Germany) at one of extremes to separate the different fractions. Mobile phase was chloroform : ethyl acetate (9:1). Twelve fractions were detected at UV lamp, scratched and numbering as (C1-C12). All the fractions were tested for their cytotoxic activity.

**C/EBPA gene expression by real time PCR**

The buffy coat from 2 ml peripheral blood of AML patients was incubated with 40 µg of (C2) and (C9) fractions of chloroform extracts for 24 hours. This was followed by extraction of total mRNA using QIAamp RNAblood mini kit (Qiagen, Germany), then the amount of extracted mRNA was measured spectrophotometry using Nanodrop ND 1000 instrument (range 200 - 400 ng/µl). The mRNA was converted to cDNA by means of Quantitect Reverse Transcription kit (Qiagen, Germany). cDNA specific CEBPa Taqman primer and probe sets were developed using primer express software.

The nucleotide numbering throughout this study is based on the published sequence available from Applied Biosystems (AB) UK. The forward primer of CEBPa (5’-TCGGTGGACAAGAACAG-3’), the reverse primer (5’GACGCGGCTCATC-3’), and the probe ([6-FAM]-ACAAAGCCAGCAGGC-[TAMRA-6-FAM]). For normalization primers and probe for reference GAPDH gene were used (Applied Biosystems). The probe was labeled with VIC dye and to avoid competition in the PCR reaction tube, the concentrations of primers were adjusted.

All PCR reactions were performed on the Step one AB. In total 10 µg of the reverse transcription volume was used for each PCR reaction in a total volume of 50 µl. Primer and probe concentrations for the CEBPA gene were optimized using manufacturer’s procedure. For CEBPa mRNA; 15 pmol for forward and reverse primers and 10 pmol for the probe were used. The conditions of PCR cycles comprised of 10 min at 95°C, 45 cycles of denaturation for 15 s at 95°C and annealing for 1 min at 60°C.

**Calculation of C/EBPA expression results**

To quantify the relative expression of C/EBPA, the Ct (threshold cycle) values were normalized for endogenous reference or housekeeping gene (GAPDH) 
\[
\Delta C_t = C_t^{\text{sample}} - C_t^{\text{GAPDH}}
\]
and compared with a calibrator or controllers, using the ‘delta–delta Ct method’ \[
\Delta \Delta C_t = \Delta C_t^{\text{sample}} - \Delta C_t^{\text{average control}}
\]. Using the \( \Delta C_t \) value, the relative expression was calculated as ratio \( 2^{-\Delta \Delta C_t} \) (Barjesteh, 2003).

**Statistical analysis**

All analyses were performed in triplicate and data reported as mean ± standard deviation. Data were subjected to analysis of variance (ANOVA) (Duncan Test \( P \leq 0.05 \)). Results were processed by Excel (Microsoft Office 2010) and Assistat Version 5.0.3.32 (Paraiba state, Brazil).

**C/EBPA gene statistical analysis**

Quantitative data were presented as minimum, maximum, mean and standard deviation (SD) values. Data showed non-parametric distribution so Mann-Whitney U test was used for comparisons between two groups. The significance level was set at \( P \leq 0.05 \). Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

**Results and Discussion**

**Phytochemical constituents**

The total phenols, flavonoids content were determined in methanol, ethanol, acetone, ethyl acetate and chloroform extracts. The phenolic and flavonoid contents were calculated using the following equations:

Absorbance/Slop. \( (Y = 0.0247x \text{ at } R^2=0.9369) \) \( (Y= 0.0051x \text{ at } R^2=0.9718) \), respectively. The obtained data were showed in table 1. The methanol extract of S. lappa showed highest contents of phenols \((69.64±3.46 \mu g \text{ GAE/g DW})\) followed by acetone extract \((57.35±1.02 \mu g \text{ GAE/g DW})\) and chloroform extract \((41.56±2.6 \mu g \text{ GAE/g DW})\). While, the results of flavonoids can be ordered as acetone, ethanol, methanol, chloroform, ethyl acetate \((34.9±0.94 \mu g \text{ GAE/g DW})\), \((32.1±1.42 \mu g \text{ QE/g DW})\), \((30.72±1.69 \mu g \text{ QE/g DW})\), \((22.75±2.89 \mu g \text{ QE/g DW})\), \((18.43±0.52 \mu g \text{ QE/g DW})\) respectively. This is in agreement with Chang et al., (2012). Who found that the total phenols ranged from 20.36± 0.14 to 44.54± 0.61 (µg GAE/g DW) and total flavonoid ranged from 15.75±0.94 to 92.15±0.05 (µg QE/g DW). Also, Saha et al., 2013 reported a high content of total phenols \((31.59± 4.18 \text{ mg GAE/g DW})\) and a low content of total flavonoid \((5.0 ± 0 \text{ mg QE/g DW})\) for S. lappa in ethanol extract. That proved the high polarity of methanol, ethanol and acetone showed high efficient to separate polar phytochemical compounds such as phenols and flavonoids.

**Table 1:** Total phenols (TP), total flavonoid (TF) in different solvent extracts of S. lappa roots.

<table>
<thead>
<tr>
<th>Extract</th>
<th>TP (µg GAE/g DW)</th>
<th>TF (µg QE/g DW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>69.64±3.46</td>
<td>30.72±1.69</td>
</tr>
<tr>
<td>Ethanol</td>
<td>34.9±0.94</td>
<td>32.1±1.42</td>
</tr>
<tr>
<td>Acetone</td>
<td>57.35±1.02</td>
<td>34.7±0.85</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>24.43±2.23</td>
<td>18.43±0.52</td>
</tr>
<tr>
<td>Chloroform</td>
<td>41.56±2.6</td>
<td>22.75±2.89</td>
</tr>
</tbody>
</table>

GAE: Gallic acid, QE: quercetin.
On the contrary, non-polar solvent such as chloroform and ethyl acetate are unsuitable for separation of polar phenolic and flavonoid compounds. The results were mean values± standard deviations (SD) of duplicate analyses of three replications.

**Antioxidant activity**

**DPPH scavenging activity**

Several methods have been developed to measure the efficiency of antioxidants as pure compounds or in extract. These methods focused on different mechanisms of the oxidant defence system that is scavenging active oxygen species and hydroxyl radicals, inhibiting lipid peroxidation, or chelating metal ions (Dorman, 2003). DPPH is a stable free radical that accepts an electron or hydrogen radical and becomes a stable diamagnetic molecule (Garg, 2016). Antioxidant activity by DPPH method for *S. lappa* roots extracts using various solvent systems and synthetic antioxidant BHT; were described in table 2. The methanol extract showed the highest antioxidant activity for all concentrations compared with BHT as a positive control which ranged from 84.77±0.82 % to 88.1±1.39 % followed by acetone extract which ranged between from 56.97±1.05 to 87.87±2.04. Also, the chloroform extract showed high results (83.86±2.62) and (79.84±0.47) at 800, 1000 ppm, respectively. While, the ethanol and ethyl acetate extracts showed moderate antioxidant activity. The DPPH activity depended on the concentration of extracts; it increased significantly with increasing concentration of extracts. This is in agreement with Chang et al., 2012 and Garg et al., 2016.

**Reducing power activity**

The reducing power assay used to evaluate the ability of an antioxidant to donate the electron because the reduction of Fe²⁺ into Fe³⁺ were used as indicator for the reducing power of the compounds. Yildirim et al. (2000) In this study, the reducing power of *S. lappa* extracts was determined using Gallic acid as standard, the linear equation Y= 0.0129x used to calculate the reducing power activity table 3. The highest reducing power result was obtained in the methanol extract at 1000 ppm (48.12±1.01 μg/ml GAE), followed by ethyl acetate extract (32.9±0.57 μg/ml GAE) and ethanol extract (20.90±0.71 μg/ml GAE). Ethyl acetate extract recorded the highest results at (200, 400, 600, 800) ppm. These findings indicate that the antioxidant activity is well correlated with the amount of phenolic and flavonoid constituent found in the extracts.

The reducing capacity of a compound may serve as a significant indicator of its potential antioxidant activity. It was found that in general, the reducing power of the *S. lappa* powder extract gave high effect with methanol and ethyl acetate extracts. While, the reducing power showed moderate result with ethanol extract. The acetone and chloroform extract had a low reducing power of less than 15 μg/ml GAE.

**Cytotoxic activity**

The cytotoxic activity of the tested five extracts on three leukemic cell cultures AML, CML, ALL at different concentrations (100, 200 and 300 ppm) was determined. The highest percentage of cytotoxic activity in three leukemic cell cultures was found in chloroform extract which ranged from 78.93±2.68 % to 95.58±1.25 % followed by ethyl acetate extract which ranged from 75.0±1.7 to 93.54±0.7. While, the methanol, ethanol and acetone extracts showed the moderate percentage of cytotoxic effect with ranges (60.41±3.12 - 70.38±0.87), (58.35 ±4.01 - 69.56±2.67) and (41.77±4.48 - 62.63±1±1.5), respectively. At all concentrations tested, all extracts exhibited dose-dependent cytotoxic activity. Detailed analysis for the values listed in (tables 4, 6) and the results suggested that extracts obtained by chloroform and ethyl acetate represented good anticancer agents.

The cytotoxic activity of different twelve chloroform fractions which were separated by TLC was tested on AML cells using concentration 100, 200 and 300 ppm and the endoxan was used

<table>
<thead>
<tr>
<th>Extract</th>
<th>DPPH antioxidant activity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>83.70±0.57</td>
</tr>
<tr>
<td></td>
<td>Ethanol</td>
</tr>
<tr>
<td></td>
<td>54.61±3.05</td>
</tr>
<tr>
<td></td>
<td>Acetone</td>
</tr>
<tr>
<td></td>
<td>56.97±1.05</td>
</tr>
<tr>
<td></td>
<td>Ethyl acetate</td>
</tr>
<tr>
<td></td>
<td>18.03±2.51</td>
</tr>
<tr>
<td></td>
<td>Chloroform</td>
</tr>
<tr>
<td>BHT</td>
<td>57.35±0.69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extract</th>
<th>DPPH antioxidant activity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>5.42±0.48</td>
</tr>
<tr>
<td></td>
<td>Ethanol</td>
</tr>
<tr>
<td></td>
<td>6.72±0.55</td>
</tr>
<tr>
<td></td>
<td>Acetone</td>
</tr>
<tr>
<td></td>
<td>6.04±1.4</td>
</tr>
<tr>
<td></td>
<td>Ethyl acetate</td>
</tr>
<tr>
<td></td>
<td>13.56±0.27</td>
</tr>
<tr>
<td></td>
<td>Chloroform</td>
</tr>
<tr>
<td>BHT</td>
<td>5.45±0.16</td>
</tr>
</tbody>
</table>
Table 4: Cytotoxic activity of *S. lappa* root extracts on AML cell culture.

<table>
<thead>
<tr>
<th>Extract</th>
<th>(Dead cells %) 100 ppm</th>
<th>(Dead cells %) 200 ppm</th>
<th>(Dead cells %) 300 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>60.41±3.12</td>
<td>62.82±3.08</td>
<td>66.55±2.1</td>
</tr>
<tr>
<td>Ethanol</td>
<td>58.35±4.01</td>
<td>63.71±4.44</td>
<td>59.65±2.67</td>
</tr>
<tr>
<td>Acetone</td>
<td>41.77±4.48</td>
<td>50.24±4.13</td>
<td>52.58±2.77</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>75.0±1.7</td>
<td>79.98±1.21</td>
<td>87.67±0.4</td>
</tr>
<tr>
<td>Chloroform</td>
<td>78.93±2.68</td>
<td>82.75±2.93</td>
<td>91.51±1.64</td>
</tr>
<tr>
<td>Positive controls</td>
<td>77.17±1.89</td>
<td>81.89±1.36</td>
<td>90.36±0.3</td>
</tr>
</tbody>
</table>

as positive control, table 7. The highest cytotoxic activity was found in the 2nd chloroform (C2) and 9th chloroform (C9) fractions which ranged between (58.23±1.58 - 88.41±0.97) and (74.96±2.14 - 77.53±2.44) respectively. The other ten fractions came in the second rank which gave moderate cytotoxic activity. The results were mean values± standard deviations (SD) of three replications. This is in accordance with Thara et al., 2012 and Zahara et al., 2014 who reported that the *S. lappa* extracts showed a high cytotoxic effect.

Molecular studies (C/EBPA gene expression)

The cytotoxic effect of twelve fractions (C1 – C12) which were isolated from chloroform extract using TLC technique was tested against AML cells and normal buffy coat cells. The data revealed that (C2) and (C9) fractions recorded the highest percentage of cytotoxic activity. Hence, the effect of these two fractions on C/EBPA gene expression of AML was estimated.

In the present study, C/EBPA gene expression in AML patients compared to the ninth chloroform fraction (C9) table 8 showed statistically significant difference (p value =0.008). However; C/EBPA gene expression of AML leukemic cells compared to theuffy coat cells of second chloroform fraction (C2) - table 9 showed no statistically significant difference (p value =0.421).

Some plants derived products are known to selectively induce apoptosis in cancer cells, which represent the ideal property for successful cytotoxic agents, other researchers reported about the biological and molecule effects of *S. lappa* on cell proliferation, growth and also apoptosis. Regarding C/EBPA gene expression in leukemic cells after addition of chloroform fractions (C2+C9) from the *S. lappa* plant, we found a statistically significant difference (P value 0.008) with (C9) compound; this denotes the higher cytotoxic activity of (C9) on the leukemia cells. According to our best knowledge data regarding this issue were not reported in literature.

The most known important compounds separated from the plant of *S.lappa* are the Costunolide (CE) and dehydrocostuslactone (DE), which are considered natural sesquiterpene lactones. They have been reported for their potential cytotoxic activities and their anticancer mechanisms, including cell cycle arrest, promoting the aggregation of microtubule protein, apoptosis and differentiation, inhibiting the activity of telomerase, reversing multidrug resistance, inhibiting metastasis and invasion of cancer cells. Most studies indicated that the α, β-unsaturated carbonyl group in the α-methylene-γ-
butyrolactone inside of CE and DE perhaps play some axil roles through conjugation with mercapto (SH)-groups of target proteins to intervene in some key biological processes in cells. Cateni 2006 and Romagnoli 2005 Many studies proved that CE and DE inhibit cell cycle progression through an increase of the G2/M phase combined with a depletion of the G0/G1 phase in various cancer cells. Rasul, 2013 Also, Choi et al., reported that CE and DE can deplete intracellular thiols and lead to the generation of reactive oxygen species (ROS) in cells, which will induce DNA damage and cancer cell apoptosis. Taken together, the activation of p53/p21/p27 is a very common mechanism of anti-cancer activity for secondary metabolites in plants.

Further studies are needed to elaborate on the different applications of anticancer natural compounds in the oncology field to offer patients additional hope.

**Conclusion**

Determination of the antioxidant and cytotoxic activities of five extracts of *S. lappa* was the main purpose of this study, in addition to the separation of active ingredients of the promising extract. The total phenols, flavonoids content were determined. The methanol extract mentioned the highest phenolic, on the other hand, the greatest flavonoids recorded to acetone extract. The antioxidants of tested extracts were estimated using different assays. The methanol and chloroform extract showed excellent antioxidant across the two assays used and the methanol extract revealed the best reducing power. The Data of The cytotoxic activity on three leukemic cell cultures AML, CML, ALL indicated that the chloroform extract recorded the highest percentage of cytotoxic activity against three leukemic cell cultures and the results suggested chloroform and ethyl acetate extracts represented good anticancer agents. Eleven fractions of promising chloroform extract were separated by TLC and tested on AML cells. The 2nd chloroform (C2) and 9th chloroform (C9) fractions revealed very good cytotoxic activity. Hence, the effect of these two fractions on C/EBPA gene expression of AML was measured. The data summarized that only ninth chloroform fraction (C9) showed a statistically significant difference on that gene expression. The most known important compounds separated from the plant of *S.lappa* are two sesquiterpene lactones : the Costunolide and dehydrocostest lactone so this study suggested that the two effective fractions C2 and C9 may belong to these sesquiterpenes. The chemical identification of the separated fractions with cytotoxic properties must be done. In future further studies of *S. lappa* for the elucidation of the cytotoxic mechanisms considered as immense importance. It is anticipated that *S. lappa* would be a source of useful pharmaceutical materials to deal with leukemia.

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