Anti-cancer potential of the lipoidal and flavonoidal compounds from *Pisum sativum* and *Vicia faba* peels

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**Abstract**
For a long time, plant secondary metabolites have been strongly examined for their antitumor and cytotoxic impacts. These days, there is another pattern of making utilization of the waste products of plants because of their extravagance of numerous phytochemical components and adequacy on human wellbeing. This research work is handling the effect of diversity of lipoidal and phenolic compounds found in the peels of two common edible plants in the Middle East: *Pisum sativum* and *Vicia faba* L. for their assessment as anticancer agents. The GC/MS of the n-hexane extract of both plant peels led to identification of twenty compounds (82.99%) and seventeen compounds (85.97%) of the total lipid contents from *P. sativum* and *V. faba*, respectively. While the HPLC analysis of the ethyl acetate fraction of the two plant peels resulted in recognition of 17 flavonoids and 18 phenolics from *P. sativum* and 16 flavonoids and 17 phenolics from *V. faba*. Moreover, four flavonoidal compounds were isolated to our knowledge for the first time from the peels and tested separately against different human cancer cell lines and the mode of action of the most potent compound has been determined. *P. sativum* ethyl acetate fraction possessed the highest scavenging activity (31.2%) as well as the most cytotoxic effect on breast carcinoma cell line. Apigenin proved to be the most potent tested compound on (MCF-7) and has no cytotoxic effect on normal human skin cell lines.

**Keywords:** Lipoidal matter, Flavonoids; *Pisum sativum*; *Vicia faba*; Anti-cancer

1. Introduction
Peels of vegetables and fruits are frequently tossed or used to feed the livestock and as fertilizers. These wastes are profoundly inclined to microbial spoilage and thusly create significant issues to the environment. So that, these wastes ought to be figured out how to be used advantageously. Nowadays, many studies are performed to utilize these wastes to reduce the environmental pollution and get some medicinal benefits [1]. Where fruit peels are an important source of bioactive compounds mainly as antioxidant and anticancer agents against colon, prostate and breast cancers [2]. Therefore, it is necessary to unveil the biological activities of these peels and take the benefits from their waste materials, in addition to investigate their chemical composition to encourage adequate reuse of these wastes for several applications in the medicine [3].

It has turned out to be certain that tumor is the principle driving reason for death in developed countries as well as developing countries. Mankind has been struggling with great efforts to get improved and discover cheaper treatments with fewer drawbacks to decrease the commonness of this disease and its resulting mortality. Legumes are well known of being rich in many bioactive non-nutrient components (phytochemicals) alongside their nutritional valued compounds (protein, carbohydrates, dietary fibers, and vitamins). Both plants under study belong to family Fabaceae. *Pisum sativum* L. is commonly known as the green pea or garden pea. In 2002, Troszynhska et al. [4] proved that the acetone extract of the seed coat has antibacterial, antiadipic, antifungal, anti-inflammatory, antihypercholesterolemic, antioxidant and anticancer properties. The HPLC analysis of the phenolic compounds in the same study showed the presence of some phenolic acids (benzoic, cinnamic acids, and their derivatives as well as some flavonoids (apigenin-7-glucoside, quercetin-3-rhamnoside, kaempferol-3-glucoside as well as other flavonoids). On the other hand, *Vicia faba* L. is among the oldest plant in the world [5], and considered an essential source of protein and energy as it is rich in a large amount of amino acids [6], also a potent source of levodopa; a precursor of dopamine, so that, it can be used for the treatment of Parkinson’s disease [5].

The present study focused on phytochemical evaluation of lipoidal and phenolic extracts in the peels of *Pisum sativum* L. and *Vicia faba* L. for their asessment as anticancer agents.
2. Materials and methods

2.1. Material for phytochemical study

2.1.1. Plant material
The fresh fruits of both *Pisum sativum* and *Vicia faba* were collected from local markets in Cairo, Egypt in February 2016. Each species was peeled off; the peels were dried in shades, then grinded and kept in sealed bags.

2.1.2. Preparation of the extracts
The dried powdered peels of *P. sativum* and *V. faba* were separately defatted with *n*-hexane then extracted with ethyl acetate several times. The obtained four extracts were concentrated under reduced pressure at 45 °C using the rotary evaporator to 1/10th of the initial volume and kept in refrigerator for the further studies.

2.1.3. Chemicals and reagents
All the chemicals and reagents were of analytical grade and purchased from Merck.

2.1.4. GC/MS analysis of the lipoidal extracts
The *n*-hexane extract of both plant peels were analyzed using GC/MS technique for identification of sterols, terpenes and fatty acid methyl esters.

2.1.5. HPLC determination of phenolics and flavonoids
High-performance liquid chromatography (HPLC) using Agilent Technologies 1100 series liquid chromatograph coupled with an auto sampler and a diode-array detector was performed for the identification and quantification of flavonoids and phenolics in the ethyl acetate fraction of *P. sativum* and *V. faba* according to [7] and [8].

2.1.6. Screening of phenolics and flavonoids
The initial screening for the ethyl acetate fractions of both plants was carried out separately with the basic qualitative test for flavonoids, where 0.5 ml of the extract was mixed with 2 ml of conc. H₂SO₄ and few magnesium turnings. Further, Thin Layer Chromatography (TLC) of the extract was carried out using the rotary evaporator to 1/10th of the initial volume and kept in refrigerator for the further studies.

2.1.7. Isolation and purification of flavonoids
The developing of the ethyl acetate fractions of both species was carried out separately on preparative TLC using Chloroform–methanol (90: 10 v/v) as developing system. The plates were examined under the UV light at 254 and 366 nm, resp. [10] and [11], and subjected to AlCl₃ solution. The selected bands marked and scratched then collected. The *Rf* values of the isolated compounds were recorded and co-chromatographed against the available authentic flavonoids for the confirmation of the isolated compounds at the same *Rf*, the isolated compounds were identified by different spectral analyses (UV, H¹-NMR, IR and MS spectrometry).

Determination of melting point and different Spectral Analyses: Koffler’s heating stage microscope was used to determine the melting point. UV–Visible Spectrophotometer double beam UVD–3500 spectrophotometer, Labomed, Inc., Visible Spectrophotometer, Shimadzu UV 240 (PIN 204-58000) (Japan), Infrared spectrophotometer, Perkin-Elmer 283 (Germany), Nuclear Magnetic Resonance spectrometers JEOL EX-270 MHz, 300 MHz and 500 MHz for determination of H¹-NMR, Mass spectrometer; Finnigan Model 3200 at 70 eV.

2.2. Material for antioxidant and cytotoxic study

2.2.1. Free radical scavenging activity
The four extracts were screened at 50 μg/ml using 0.1 mM DPPH•. The absorbance was measured at 517 nm, after 30 min incubation [12]. Ascorbic acid was used as standard reference [13].

2.2.2. Chemicals
DPPH• was obtained from Fluka. Vitamin C (ascorbic acid) obtained from Laboratory Rasayan. Methanol used was of analytical grade.

2.2.3. Cell lines
Human breast carcinoma (MCF-7 cell line) and colon carcinoma (HCT-116 cell line) were obtained from Karolinska Center, Department of Oncology and Pathology, Karolinska Institute and Hospital, Stockholm, Sweden.

2.2.4. Determination of LC50 values
It was performed using SPSS computer program (SPSS for windows, statistical analysis software package/version 9/1989 SPSS Inc., Chicago, USA).

2.2.5. Cell culture
The procedure was done in laminar air flow cabinet biosafety class II level. Culturing and subculturing were carried out according to Thabrew et al. [14], Doxorubicin was used as a positive control. DMSO used as negative control.

2.2.6. Cell viability assay
This was done according to Mosmann et al. [15]. The cells were seeded at concentration of 10x10³ cells/well in case of MCF-7, 20 x 10³ cells/well in case of HCT-116 cell lines using 96-well plates at 37 °C. After 48 h incubation, the medium was aspirated and 40 μl MTI salt (2.5 mg/ml) were added and further incubated for 4 h. 200 μl 10% sodium dodecyl sulphate (SDS) was added. The absorbance was measured at 595 nm.

2.2.7. Measurement of Bcl-2 levels
BCL-2 in the samples and standards were estimated according to [16]. A biotin-conjugated antibody was added followed by streptavidin-HRP. The reaction is then terminated by addition of acid and absorbance was measured at 450 nm.

2.2.8. Measurement of Bax levels
Bax protein level were evaluated according to [17]. Monoclonal antibody specific to Bax captured on the plateis added. After incubation, Streptavidin conjugated to Horseradish Peroxidase is added. The reaction is terminated by the addition of acid and optical density of the color produced measured at 450 nm.

2.2.9. Human CASP7 (Caspase 7) estimation
The micro ELISA plate provided in this kit pre-coated with CASP7 specific antibody. A biotinylated CASP7antibodyand Avidin-Horseradish Peroxidase (HRP) conjugate was added. Aspire the excess components. The substrate solution was added. wells that contain CASP7, biotinylated detection antibody and Avidin-HRP conjugate will appear blue in color. The color turns yellowfol-
lowed the addition of sulphuric acid solution. The optical density (OD) was measured at a wavelength of 450 nm ± 2 nm. [18].

3. Results

3.1. GC/MS analysis of the lipoidal extracts

GC/MS analysis of the n-hexane extracts of P. sativum and V. faba was performed, and identification of the constituents was carried out by comparison of their spectral fragmentation patterns with those of the available database libraries Wiley (Wiley Int.) USA and NIST (Nat. Inst. St. Technol., USA) and/or published data in Adams [19] using Agilent 6890, 70 eV with positive ion mode. Quantitative determination was carried out based on peak area integration. The identified components are compiled in Tables 1 and 2. Twenty compounds were identified from the lipoidal matter of P. sativum, representing 82.99% of the total content from which 2, 2-dimethyl-1-(2,4,6 trimethylphenyl) was the major compound (12.56%) followed by 6-Phenylundecane (12.18%). Nevertheless, seventeen compounds were identified from V. faba representing 85.97% of the total lipidial content, 5-phenylundecane was identified as the main compound of V. faba (23.24%) followed by 2-(Benzoxyloxy) cycloheptanone (12.74%).

3.2. Identification and quantification of phenolics and flavonoids

Tables 3 and 4 summarize the results of HPLC analysis of the ethyl acetate fraction of both plant peels. The total identified flavonoids from P. Sativum were 17 compounds representing 19.31 mg/g of the total content, while 16 compounds were identified for V. faba representing 12.30 mg/g dry weight of the whole fraction. Hesperidin was found to be the major flavonoid in both plants recording (6.10 mg/g) for P. sativum and (2.46 mg/g) for V. faba. On the other hand, regarding the results of total identified phenolics, 18 compounds were identified from P. sativum (89.65 mg/g) of dry weight of which pyrogallol (8.61 mg/g) was the main phenolic followed by catechol (8.53 mg/g). Moreover, 17 phenolic compounds were identified from V. faba and the total phenolic content recorded (62.40 mg/g). Pyrogallol also was the main compound identified (8.50 mg/g) followed by ρ-hydroxy benzoic acid (8.10 mg/g). These recordable numbers of phenolics with reasonable amounts were very encouraging for the cytotoxic study.

| Table 1 |
| Compound | Mol. Weight | BP | Relative area % |
| n-Dodecane | 170 | 43 | 3.61 |
| n-Tridecane | 184 | 43 | 4.75 |
| Dodecanol | 186 | 41 | 2.31 |
| Decanol | 204 | 147 | 12.56 |
| Di-t-butylphenol | 206 | 191 | 4.35 |
| Tetradecanol | 214 | 41 | 1.77 |
| (4E,8E)-5-Propyl trideca-4,8-dien-6-yn | 218 | 91 | 2.77 |
| 2-Phenyl Decane | 218 | 105 | 3.89 |
| 6-Phenylundecane | 242 | 91 | 12.18 |
| 6-Phenylundecane | 246 | 91 | 10.63 |
| n-Hexadecanonic acid | 256 | 43 | 10.35 |
| 6-Phenyl tridecane | 260 | 91 | 7.12 |
| 2-Phenyl tridecane | 260 | 105 | 0.81 |
| 8,8-Dihydrocyclohept phenalen-7,10-dione | 260 | 91 | 0.86 |
| Octadecanol | 270 | 41 | 2.80 |
| n-Decosane | 310 | 43 | 0.28 |
| Pregn-4-ene-3,20-dione | 314 | 124 | 0.20 |
| 9-11 hexyl heptadecane | 312 | 43 | 0.28 |
| Tetracosane | 338 | 57 | 4.67 |
| 4-Phenyl Eicosane | 358 | 91 | 1.01 |
| Hydrocarbons | 379 | 43 | 1.77 |
| Fatty alcohols | 312 | 43 | 0.28 |
| Ketones | 370 | 21 | 0.30 |
| Acids | 302 | 103 | 0.53 |
| Total identified | 8299 |

| Table 2 |
| Compound | Mol. Weight | BP | Relative area % |
| n-Decane | 142 | 57 | 0.68 |
| Nonanal | 142 | 41 | 3.67 |
| Decanol | 158 | 41 | 1.12 |
| Dodecanol | 186 | 41 | 0.74 |
| 3-Methyl pentenyl phenyl ketone | 188 | 161 | 2.61 |
| 7-phenyl Tridecane | 218 | 91 | 6.03 |
| Pentadecanol | 228 | 41 | 3.91 |
| 5-phenylundecane | 232 | 91 | 23.24 |
| 2-(Benzoyloxy)cycloheptanone | 232 | 105 | 12.74 |
| n-Heptadecane | 240 | 57 | 2.61 |
| Hexadecanol | 242 | 41 | 3.65 |
| 7,7-Diphenyl-2,4,6-heptatrienial | 260 | 260 | 8.91 |
| Methyl palmitate | 270 | 74 | 6.24 |
| n-Eicosene | 280 | 41 | 2.24 |
| Methyl linoleate | 294 | 67 | 5.56 |
| n-Heneicosane | 296 | 57 | 0.90 |
| α, α-Carotene4,4′-dione | 564 | 83 | 1.12 |
| Hydrocarbons | 379 | 43 | 1.77 |
| Fatty alcohols | 312 | 43 | 0.28 |
| Ketones | 370 | 21 | 0.30 |
| Esters | 312 | 43 | 0.28 |
| Total identified | 8597 |

| Table 3 |
| Flavonoids | Concentration (mg/100 g) |
| Pisum sativum | Vicia faba |
| Apigenin-6-arabinose-8-galactose | 170.0 | 68.46 |
| Apigenin-6-rhamnose-8-glucose | 357.13 | 185.53 |
| Naringin | 201.4 | 109.79 |
| Hesperidin | 605.94 | 245.85 |
| Rutin | 83.01 | 0.90 |
| Apigenin-7-O-neohesperidoside | 104.13 | 027.30 |
| Kaempferol-3,7-dihannoside | 013.26 | 008.20 |
| Quercetin | 256.26 | – |
| Apigenin-7-glucose | 147.59 | 015.48 |
| Acacetin-7-ne hesperides | 136.87 | 043.28 |
| Acacetin neo rutinoside | 061.77 | 073.71 |
| Quercetin | 056.90 | 095.20 |
| Naringenin | 024.59 | 071.98 |
| Hesperitin | 158.29 | 112.28 |
| Kaempferol | 015.79 | 016.61 |
| Rhamentin | 248.32 | 070.12 |
| Apigenin | 014.31 | 056.41 |

Apigenin: Yellow colored amorphous powder, melting point: 180–181 °C, UV: deep purple, UV/NH3: yellow green, Rf 0.87 using Chromoraf–methanol (90:10 v/v) as developing system, UV λ MeOH max (nm) 267, 296 sh, 336; +NaOMe 275, 324, 392; +AlCl3 276, 301, 348, 384; +AlCl3 – HCl 276, 299, 340, 381 nm; +NaOAc 274, 301, 376; +NaOAc – H2BO3, 268, 303sh, 338. IR data showed a broad intermolecular OH stretch vibrations band at 3333 cm⁻¹, an aromatic C-H stretch appeared at 3040 cm⁻¹, in addition to a vibration band at 1646 cm⁻¹ characteristic for flavone of conjugation between the C=O and double bonded of C2–C3, also, 1801 cm⁻¹ for lactone ring, in addition to three vibration bands at (1466, 1497, and 1578 cm⁻¹) for the ring C=C, while
1466 cm$^{-1}$ denotes the characteristic of C–O–H stretch. The intensive band at 1024 cm$^{-1}$ was most probably the result of C–O–C stretch from the central heterocyclic ring. H$^1$-NMR (400 MHz, CH$_3$OH): δ 7.75 (2H, d, J = 8.3 Hz, H–2' and H–6'), 6.86 (2H, d, J = 8.3 Hz, H–3 and H–5'), 6.79 (1H, d, J = 2.1 Hz, H–6), 6.68 (1H, d, J = 2.1 Hz, H–8), 6.47 (d, J = 1.1, 1H) and H–6 at δ 6.21 (d, J = 1.5, 1H), H–2' at δ 7.74 (d, J = 2.2, 1H–6'), H–5' showed at δ 6.95 (d, J = 8.4, 1H–6'), H–6' at 7.64 (d, d, J = 2.2, 1H–2') and H–5'. Mass Spectrum illustrated the [M]$^+$ at 302 (100%) for molecular formula C$_{15}$H$_{10}$O$_5\cdot$HCl, beside other main fragments at m/z with relative abundance: 301 (60%), 151 (58%).

Quercetin: It was in the form of yellow amorphous powder, melting point: 315–316 °C; UV: yellow, UV/ NH$_3$: yellow, R$_f$ 0.55, UV data λ MeOH max (nm) 255, 269 sh, 301 sh, 370; +NaOMe 247, 321; +AlCl$_3$ 272, 304 sh, 333, 458; +AlCl$_3$ – HCl 265, 301 sh, 359, 428 nm; +NaOAc 257 sh, 274, 329, 390; +NaOAc – H$_2$BO$_3$ 261, 303 sh, 388 IR data: at 3421.20 cm$^{-1}$ represents bending of methylene and methyl group, peak between 1371.50 cm$^{-1}$ and 1466 cm$^{-1}$ represents aromatic ring system, δ 302 (100%) for molecular formula C$_{15}$H$_{10}$O$_7\cdot$HCl, beside other main fragments at m/z with relative abundance: 301 (60%), 151 (58%).

46. Structure characterization of the isolated phenolics from V. faba

**Table 4**

| Phenolic compounds     | Concentration (ppm) | Pisum sativum | Vicia faba |
|------------------------|---------------------|--------------|------------|
| Gallic acid            | 451.8               | 15.44        | 15.44      |
| Pyrogallol             | 286.06              | 850.38       | 850.38     |
| 4-Amino benzoic acid   | 152.7               | 112.63       | 112.63     |
| Protocatechic acid     | 426.15              | 400.36       | 400.36     |
| Catechin               | 795.74              | 599.65       | 599.65     |
| Chlorogenic acid       | 742.28              | 197.24       | 197.24     |
| Catechol               | 852.94              | 138.36       | 138.36     |
| Caffeine               | 566.52              | 194.47       | 194.47     |
| α-Hydroxy benzoic acid | 588.94              | 810.02       | 810.02     |
| Caffeic acid           | 146.11              | 106.54       | 106.54     |
| Vanillic acid          | 536.67              | 150.76       | 150.76     |
| Caffeic acid           | 536.67              | 150.76       | 150.76     |
| Phenolic compounds     | 462.93              | 609.38       | 609.38     |
| Furicolic acid         | 788.29              | 1078.21      | 1078.21    |
| Iso-Ferulic acid       | 210.39              | 971.50       | 971.50     |
| Ellagic acid           | 433.87              | 322, 372     | 322, 372   |
| Alpha coumaric acid    | 492.22              | 533, 430     | 533, 430   |
| Benozoic acid          | 492.22              | 533, 430     | 533, 430   |
| 3,4,5-Methoxycinnamic acid | 477.43           | 2932.54      | 2932.54    |
| Cinnamic acid          | 206.97              | 2932.54      | 2932.54    |

1 represents aromatic ring system, H$^1$-NMR (400 MHz, CH$_3$OH): δ 7.64 (d, d, J = 2.2, 1H–2), 7.51 (1H, d, J = 8.4, 1H–6), 6.95 (d, J = 8.4, 1H–6), H–6' at 7.64 (d, d, J = 2.2, 1H–2') and H–5'. Mass Spectrum illustrated the [M]$^+$ at 302 (100%) for molecular formula C$_{15}$H$_{10}$O$_5\cdot$HCl, beside other main fragments at m/z with relative abundance: 301 (60%), 151 (58%).

**Fig. 1.** The antioxidant activities of the four extracts, in vitro, using the DPPH• assay.
4. Results of antioxidant and cytotoxic study

4.1. Free radical scavenging activity

The four extracts showed weak scavenging activity of DPPH● where *P. sativum* ethyl acetate fraction possessed the highest scavenging activity (31.2%) followed by *V. faba* ethyl acetate fraction (9.8%) as showed in Fig. 1.

4.2. Cytotoxic study of the four extracts

The four extracts were preliminary screening at 100 ppm for their antiproliferative effect using two human tumor cell lines [human breast carcinoma (MCF-7), human colon carcinoma (HCT-116)]. *P. sativum* ethyl acetate fraction showed high activity over breast cancer cell line with 73.6% and low activity over colon tumor cell line (HCT-116) with 21% while *P. sativum* n-hexane extract exhibited 26.1, 28.3 on both cell lines, resp. On the other hand *V. faba* n-hexane extract gave 40.2 and 6.7, while *V. faba* ethyl acetate fraction 32.3, 22.1 over both MCF-7 and HCT-116, respectively. Fig. 2. The *P. sativum* ethyl acetate fraction which possessed the highest activity over breast carcinoma cell line was further assayed at lower concentrations to calculate its LC₅₀ which was calculated as 73.4 ± 1.7 on Breast carcinoma cell line.

5. Cytotoxic study of the isolated compounds

The four compounds were tested for their cytotoxic activity over [(MCF-7) and (HCT-116)] as shown in Fig. 3. Apigenin possessed promising cytotoxic effect on breast cancer and colon cell line, so it is further screened over the cell lines to calculate its LC₅₀ value where it recorded the following LC₅₀ values: 44.8, 60.8 over breast and colon tumor cell line, respectively. Apigenin proved to be the most potent tested compound on (MCF-7) and has no cytotoxic effect on normal human skin cell lines, so it is directed to explore its apoptotic mode of action.

6. Apoptotic mechanism of Apigenin

Apoptosis, or programmed cell death, takes place in all living organisms. Disruption of apoptotic mechanisms could lead to the deregulation of cell proliferation. Targeting the process of apoptosis is an appropriate strategy for prevention and treatment of cancer. Based upon that apigenin effectively suppressed the growth of both...
colon and breast tumor cell line with LC50 on breast less than colon, changes in expression of apoptosis- (apoptosis-related genes) of apigenin over (MCF-7) were investigated. Quantitative estimation of Bcl2, Bax, Bax/ Bcl2 ratio and caspase 7 were determined. Bcl-2 family members are associated with the intrinsic pathway of apoptosis comprised of both pro-apoptotic (e.g. Bax, Bid) and anti-apoptotic (e.g. Bcl-2, Bcl-XL) members. Expression of the anti-apoptotic Bcl-2 in breast cancer cell line treated with apigenin was significantly decreased as compared with control "untreated breast cancer cells "as shown in Fig. 4. Apigenin resulted in an increase in Bax protein levels in MCF-7 cells chart Fig. 5. The ratio between pro- and anti-apoptotic levels an important determinant of cell survival. The Bax/Bcl-2 ratio in cells treated with apigenin increased drastically, indicating that apoptosis induced in breast cancer cells might be mediated by the mitochondrial pathway (Fig. 6). Caspase-7 is a member of the caspase family of proteins plays a central role in the apoptotic machinery. Apigenin showed increased in caspase 7 levels in treated breast cancer cell line in comparison to untreated breast cancer cell line as shown in Fig. 7.

7. Discussion

In our work we attempted to discover the correlation of the lipoidal and phenolic compounds and their impact on some human cell line carcinoma. An extensive number of hydrocarbons and triterpenoids with different groups are known to exhibit chemoprevention and cytotoxicity against many tumor cells as well as anticancer remedy both in vitro and in vivo [24–26]. Phenolics with its assorted variety of classes are famous of inducing apoptosis and cytotoxic activities on various cancer cell lines. The ability of scavenging of radicals and antioxidant properties are principally responsible for the antitumor activities of phenolic compounds.
Quantitative structure–activity relationship studies on the cytotoxic effect of phenolic compounds have been examined in the recent period by many studies [27–29]. Hesperidin, which is a major flavonoid in the ethyl acetate fractions of both plants under study, has demonstrated to protectively affect CCL₄-induced oxidative stress and resultant dysfunction of rat liver which has been correlated to its antioxidant property [30]. Another study investigated hesperidin impact on the proliferation of MCF-7 human breast cancer cells, and prostate cancer cells [31]. On the other hand, pyrogallol, a major phenolic compound identified from *V. faba* exhibited a moderate effect against prostate cancer cell in a previous study Chew et al. [32] Catechol which is another significant phenolic identified from *P. sativum* apparently turned out to have a sensible effect on two breast cancer cell lines (MCF-7 and MDA-MB-231) [33]. 

8. Conclusion

In the present investigation, it can be clearly noticed that both plant peels are wealthy in phenolics and flavonoids which assumed an important role as antioxidant and anticancer as well. Our outcomes affirmed that apigenin isolated from *P. sativum* ethyl acetate fraction caused the loss of cell viability of MCF-7 breast cancer cells and induces mitochondrial-dependent apoptosis through Bax activation, Bcl-2 down regulation and imbalance between Bcl-2 and Bax expressions which prompt mitochondria-mediated caspases pathways including activation of caspase-7. These results urge to make the best utilization of plant wastes and reconsider their pathways including activation of caspase-7. This action, of course, is far away from the plant utilization in medicine. So, the results obtained in the present research should be further validated in vivo systems.

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