Active Constituents of Kiwi (*Actinidia Deliciosa Planch*) Peels and Their Biological Activities as Antioxidant, Antimicrobial and Anticancer

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Abstract

The present investigation evaluated 4 distinct solvent compositions for their proportional capacity to extract total phenolic and total flavonoid (TF) and total tannins (TT) components of the peels of kiwi (Actinidia Deliciosa Planch) as well as to profile the composition of these plant by-product and to measure their antioxidant capacity, antimicrobial and anticancer activities. Chemical analyses offered that the content of moisture, protein, crude fat total carbohydrates and ash was 85.27% of FW, 12.62, 3.70, 76.92 and 6.50% of DW respectively. The minerals determined were: K (2300 ppm), Ca (2300 ppm), Na (900 ppm), P (600 ppm), Mg (8200 ppm), Fe (82.26 ppm), Cu (6.64 ppm), Zn (9.26 ppm) and Mn (14.83 ppm) in dried samples.

The altitude content of total phenolic flavonoid and tannin were acquired in Acetone (80%) extract. Kiwi peels acetone 80% extract possess the highest antioxidant and antimicrobial activity at 600 ppm. Kiwi peels do not show any effects against breast and hepatocellular carcinoma cells. The phenolic profile of the same extract of kiwi peels was specified by HPLC and demonstrated that the main phenolic compounds were syringic, chrysin and quercetin. These results obviously encourage the enforcement of kiwi peels as a potential candidate as natural antioxidant and antimicrobial agents.

Keywords: Kiwi peel, Chemical composition, Antioxidant, Antimicrobial and Cytotoxicity activities.

Introduction

The conversion of kiwi peels gives huge quantities of agriculture by-products. The employment of agricultural wastes could minimize the waste disposal problems and serve as a prospect novel source of proteins, fats, carbohydrates, vitamins, minerals and bioactive substances. These components are important nutrients and active constituents as a food source[1].

Accumulation of the wastes of agriculture food industry leads not only to environmental regression and pollution but also to the deprivation of materials of great economic value. These materials can be processed to produce worthy products which have economic potential health benefits such as fuel, food supplements and drug products.

Kiwi fruit belongs to the genus Actinidia (*Actinidia deliciosa*)[2]. It is a well-known highly nutritional sweet dessert because of its high level of ascorbic acid and strong antioxidant compounds such as carotenoids, lutein, phenolics, flavonoids, isoflavonoids which consider a major form of phytoestrogen. It has an important action as anti-carcinogenic[3,4] and chlorophyll source[5] as well as galactose[2]. Kiwifruit is effective not just for the convenience of consumption, but also for the intake of health-functional substances within the skin[6,7]. The current investigation is conveyed out to appreciate the enforcement of kiwi peels as a natural source of antioxidant and antimicrobial agents in food industries.

Material and Methods

Plant materials: Kiwi fruits (*Actinidia deliciosa*) were obtained from the local market at Giza, Egypt.

Chemicals and reagents: All chemicals in the present study were of analytical grade, a product of Sigma (US), Aldrich and Biodiagnostic Company.

Preparation of sample: The kiwi fruit was washed and removed from the peels using a sharp knife. The peels of kiwi were cut into small pieces, air-dried for ten days followed by drying in an oven at 40ºC for three days, ground and then stored in the refrigerator at -4 °C until extraction.

Preparation of kiwi peels extracts: The dried samples of kiwi peels (10 g) were dispensed separately in 100 ml of distilled water, 80% ethanol, 80% methanol and 80% acetone for 24 h at room temperature with shaking. The mixture was filtered through Whatmann No. 1 filter paper and the extraction step was repeated three times. The filtrate was then concentrated to dryness at 40 °C in a rotary evaporator. The crude extracts were stored in a refrigerator until analysis.

Proximate analysis: The moisture, ash, crude protein, total lipid, total carbohydrates and macro-microelements were determined according to AOAC[8].

Total phenolic content: The total phenolic content (TP) of kiwi peels extracts was spectrophotometrically determined by Folin Ciocalteu reagent assay using gallic acid as standard according to Singleton and Rossi[9]. The absorbance was determined at 750 nm using spectrophotometer (Unicum UV 300). The total phenolic content in the samples was expressed as mg gallic acid equivalents (GAE)/g dry weight sample. All samples were analyzed in triplicate.

Total flavonoid content: Total flavonoid content (TF) of kiwi peels extracts was spectrophotometrically determined by the aluminum chloride method using quercetin as a standard [10]. The absorbance was measured against blank at 510 nm by using spectrophotometer (Unicum UV 300). Total flavonoids in the sample were expressed as mg quercetin equivalents (QE)/ g dry weight. All sample:s were analyzed in triplicate.

Total tannins content: Total tannin content (TT) of kiwi peels extracts was measured using the Folin-Ciocalteu reagent according to Polshettiwar et al[11]. Absorbance was measured against prepared reagent blank at 775 nm by using spectrophotometer (Unicom UV 300). Total tannins in the sample were expressed as mg tannic acid equivalent (TE)/g dry weight sample. All samples were analyzed in triplicate.

Identification of phenolic compounds by HPLC: Phenolic compounds in kiwi peels acetone extract were identified using HPLC according to Ben-Hammouda et al.[12] The HPLC system is Agilent 1100 series coupled with UV-Vis detector (G1315B) and (G1322A) DEGASSER. Sample injections of 5 µl were made from an Agilent 1100 series auto-sampler and the chromatographic separations were performed on ZORBAX-Eclipse XDB-C18 column (4.6×250 mm, particle size 5 µm). A constant flow rate of 1 ml/min was used with two mobile phases: (A) 0.5% acetic acid in distilled water at pH 2.65 and solvent (B) 0.5% acetic acid in 99.5% acetonitrile.

The elution gradient was linear starting with A and ending with B over 50 min, using a UV detector set at wavelength 280 nm. Phenolic compounds of kiwi peels extract were identified by comparing their relative retention times with those of the standard mixture chromatogram. The concentration of an individual compound was calculated on the basis of peak area measurements and then converted to mg / 100g dry weight.

***In vitro* Antioxidant activity**

2,2-diphenyl-1-picrylhydrazyl (DPPH˙)- Free radical scavenging assay: Determination of DPPH˙ free radical scavenging activity was measured according to Chu et al.[13] The mixture was shaken vigorously and allowed to stand at room temperature. Butyl hydroxytoluene (BHT) was used as positive control while the negative control contained the entire reaction reagent except for the extracts. The absorbance was measured at 515 nm against blank. The capacity to scavenge the DPPH˙ radical was calculated using the following equation:

DPPH˙ scavenging effect (Inhibition %) = [(Ac – As / Ac)] × 100

where Ac is the absorbance of the control reaction and As is the absorbance in the presence of the plant extracts.

Determination of scavenging activities on 2, 2'-and-bis (3-ethylbenzothiazoline-6-sulphonic acid) ABTS˙⁺ radicals: Scavenging activity of ABTS˙⁺ assay was determined according to Arnao et al.[14] The absorbance was measured at 734 nm using the spectrophotometer (Unicom UV 300). Results were expressed in comparison with standard BHT. A higher antioxidant capacity of the sample exhibited a smaller production of free radicals.

Percent activity was calculated using the following equation:

% Inhibition = $[(A_0 – A_1)/A0] \times 100$

where A_0 is the ABTS˙⁺absorbance of the control reaction and A_1 is the ABTS˙⁺ absorbance in the presence of the sample.

Reducing power: The reducing power was assayed spectrophotometrically according to Kuda et al.[15] Increased absorbance values indicate a higher reducing power.

Metal chelating: Metal chelating effects on ferrous ions were carried out calorimetrically according to Minotti and Aust[16]. The absorbance was measured at 562 nm. The percentage of ferrous ion chelating ability was calculated using the following equation:

Iron chelating activity (Inhibition %) = $[(A_c – A_s / A_c)] \times 100$

where A_c is the absorbance of the control reaction and A_s is the absorbance in the presence of the plant extracts.

***In vitro* antimicrobial assay of ethanol and acetone banana and olive leaves extracts:** Different bacteria strains of gram-positive *(Bacillus subtilis NRRL B-94, Staphylococcus aureus* NRRL B-313), gram-negative *(Escherichia coli N*RRL B-3703, *Pseudomonas aeruginosa* NRRL B-32), *Aspergillus fluves* NRC *as mold, Candida albicans* NRRL 477 *and Saccharomyces cerviciea* strains as yeast were used. The measurement of growth inhibition was carried out with agar diffusion tests previously described by Greenwood[17].

Procedure: The bacterial strains were cultured in a nutrient broth media while the fungi and yeast strains were cultured in a malt broth media and yeast broth media respectively. For bacteria and yeast, the broth media were incubated for 24 h. As for molds, the broth media were incubated for 48 h with subsequent filtering of the culture through a thin layer of

sterile sintered Glass G2 to remove mycelia fragments before the solution containing the spores was used for inoculation. For plate preparation, 1 ml Tween 20 and 500 µl of inoculating were added to 50 ml of agar media 50°C and mixed by simple inversion. Wells of 6 mm diameter were then made in the solidified agar using proper sterile tubes. Plates were undisturbed for 30 min to allow diffusion of the sample (200, 400 and 600µg/l) into the agar, then incubation inverted at 30ºC for 48 h for bacteria and 72 h for fungi. The microbial growth inhibition zones and clear microbial free inhibition zones were measured after incubation at 30ºC, beginning within 24 h for yeast, 24-48 h for bacteria and 48-72 h for fungi. Antimicrobial activities were calculated as a mean of three repetitions.

***In vitro* anticancer activity:** Cell viability was assessed by the mitochondrial-dependent reduction of yellow MTT (3-(4, 5-dimethylthiazol-2-yr)-2,5-diphenyl tetrazolium bromide) to purple formazan[18].

The percentage of change in viability was calculated according to the formula:

(Reading of extract / Reading of negative control) -1) x 100

Statistical analysis: Statistical analysis is carried out using SPSS computer program (version 8) combined with co- state computer program, where unshared letters are significant at $P \leq 0.05$.[19]

Results and Discussion

Chemical studies

Chemical Composition: Kiwi peels were analyzed for moisture, ash, crude protein, crude lipid and total carbohydrate as well as macro and microelements content and data are shown in tables 1and 2. The moisture, ash and protein contents were 85.27% of FW, 6.50 and 12.62% of DW respectively. These values were higher than that obtained by Anhwange et al[20] and Shyamala and Jamuna[21].

The contents of fat and total carbohydrates were 3.70% and 76.92 % of DW respectively. The fat content was similar to that previously obtained by Mahmoudi et al.[22] Further, the total carbohydrate was higher than that recorded by same authors[22] 71 g/Kg FW but was less than that obtained by Parameswaran and Murthi[23] in two varieties of kiwi fruits.

Fruits are considered as a good source of dietary minerals[24]. Minerals perform a key function in distinct physiological vital functions of the body, mostly in the constructing and arrangement processes. The minerals content of kiwi peels powder was shown in table 2. Mg content was found to be the highest (8200 ppm) as compared to all the other minerals content followed by K, Ca, Na and P which were 2300, 2300, 900 and 600 ppm respectively. Iron content (82.26 ppm) was higher when compared to Mn, Zn and Cu contents 14.83, 9.26 and 6.64 ppm respectively.

In contrast, the results of Samadi-Maybodi and Shariat[25] showed lower contents (6.50, 34.00, 3.90, 31.60 ppm) for K, Na, Mg and Mn respectively. The variability of results can be due to several factors like variety, state of ripeness, soil type, soil condition and irrigation regime as explained by Feumba and Ragu[26] who declared that these factors cause variation in the chemical composition mineral contents in different types of fruits as well as within different parts of the same fruit.

Table 1
Proximate analysis of kiwi peels

Proximate analysis*	Composition (%)
Moisture	85.27± 0.18
Carbohydrate	76.92+0.76
Crude fat	3.70±0. 55
Crude protein	12.62± 0.56
Ash content	6.50± 0.40

* The other compounds than water were expressed to dry weigh bases.

Total phenolic (TP), total flavonoid (TF) and total tannin (TT): The preventive effectiveness of fruits and vegetable has been referred to their antioxidants ingredients inclusive of polyphenol, flavonoid and tannin which possess biological and pharmacological properties[27]. The levels of phenolic compounds in different extracts (aqueous, 80% methanol, 80% ethanol and 80% acetone) of kiwi peels are presented in table 3. Acetone extract showed the highest content of TP, TF and TT (24.54±0.21 mg GE/g DW, 24.47±0.28 mg QE/g DW and 16.76±0.26 mg TAE/g DW respectively) while ethanol extract showed the lowest content which was 14.68±0.45 mg GE/g DW 11.69±0.32 mg QE/g DW while aqueous extract of kiwi peels showed lowest TT content 10.78 mg/g DW respectively. The present results showed that the total phenolic was in the range of those reported by Park et al[28] who found that phenolic content of kiwi skin ranged from 12.47 to 26.54 mg/g DW. It has been noted that the lowest content of polyphenols ranged from 5.62 to 7.91 mg GAE/g dry weight[29].

Also, the total phenol of kiwi peels was lower than that obtained by Rice-Evans et al[30] who recorded that the polyphenol content was 37.00, 139.80 and 52.30 mg GAE/g of dry weight of three parts of kiwi fruit (pulp, rind and whole) respectively. Gorinstein et al[29] showed that the lowest contents of flavonoid and tannin ranged from 1.68mg QE/g of DW to 2.84 mg TE mg /g of DW. It has been found that lower flavonoid content of kiwi fruit 7.90 µg QE/ml was detected in methanol extract which was 1.05 mg QE/g DW in 70% ethanol extract[26]. Rice-Evans et al[30] demonstrated similar flavonoid content to our results. In addition, Gorinstein et al[29] found that the highest value of total flavonoid was 51.12 mg QE mg/100g FW. In the same time, Pal et al[31] determined the flavonoid content of kiwi fruit and found it as 2.10 mg QE/g sample extract.

The profiling of Phenolic compounds by HPLC: Individual phenolic compounds of acetone (80%) extract from kiwi peels are analyzed by HPLC. The sample was identified and quantified by external standards from gallic, protocatechuic, gentisic, catechin, rosmarinic, chlorogenic, cinnamic, caffeic, syringic, ellagic, vanillic, tannic, ferulic and sinapic acids as well as coumarin, chrysin, pyrogallol, quercetin, rutin, acacetin and oleuropein and the data are given in table 4. It was observed from table 4 that the major phenolic compounds were syringic acid (197.72 mg/100g dw) followed by chyrsin (120.40 mg/100g dw) and quercetin (84.45 mg/100gdw). Similar results were reported by Wu et al[32] who detected syringic acid which represented the major phenolic compound in the kiwi profile.

The results obtained also run in parallel with those obtained by Shehata and Soltan[33]. Among the phenolic profiles, oleuropein, tannic acid, acacetin and rutin are not detected in kiwi peels extract. Similar results were obtained by Salawu et al.[34]

Biological Studies

Antioxidant activity of various extracts from kiwi peels using DPPH˙, ABTS˙⁺, Reducing power (RP) and Fe^{2+}-Chelating assays: The results of antioxidant activity of various extracts of kiwi peels using four assays compared to synthetic antioxidant (BHT and EDTA) are shown in table 5. The DPPH˙ assay was established on the relief of the settled radical DPPH˙ to yellow colored diphenyl picrylhydrazyl in the presence of a hydrogen donor[35]. The IC_{50} of DPPH˙ scavenging capacities of kiwi peels was in the range of 108.98 –54.85 µg/ml. The lowest IC_{50} means the highest antioxidant capacity. The IC_{50} exhibited very wide range from 108.98 µg/ml (kiwi peel aqueous extract) to (54.85µg/ml g/ml (kiwi peel acetone extract 80%). Higher antioxidant activity was offered by BHT (4.73 µg/ml).

The results are in accordance with those obtained by Loganayaki et al.[36] Bekhradnia et al[27] reported high IC_{50} with kiwi fruit methanol extract. In addition, Amodio et al[37] observed that the highest value of antioxidant capacity in kiwi fruit's and the percentage of inhibition was approximately 44.00%. Finally, Rice-Evans et al[30] declared that the DPPH˙ radical inhibition of kiwi fruit is in the range of 16.02 to 64.63% and Pal et al[31] found that the IC_{50} was 7.15 mg/ml of kiwi fruit (70%) ethanolic extract.

The $ABTS^{\cdot+}$ assay was established on the antioxidant capability to react with $ABTS^{\cdot+}$ created in the system. This method is excessively used to appreciate antioxidant activity in foods and biological systems[38]. The IC_{50} of $ABTS^{\cdot+}$assay in kiwi peels various extracts was in the range from 355.19 to 22.02 µg/ml. Kiwi peels in acetone extract showed higher antioxidant activity (IC_{50}= 22.02±0.23 µg/ml) compared to BHT (15.43±0.19 µg/ml) as standard. Methanol extract of kiwi peels showed lower antioxidant activity (IC_{50}= 355.19±5.7µg/ml). These results are in parallel with those reported by Park et al[28], Rice –Evans et al[29] and Robert et al.[39]

The presence of reductants in the sample would result in the reduction of the ferric (Fe^{3+}) to ferrous ion (Fe^{2+}) through the donation of an electron and the creation of Perl's Prussian blue complex. This complex was estimated by measuring absorbance at 700 nm[40]. The increase in the absorbance (at 700 nm) indicated the reducing power of the extract components. The reducing power assay (as EC_{50}: effective concentration at which the absorbance is 0.5) of kiwi peels was between 1143.00 – 441.00 µg/ml. Acetone extract (present study) of kiwi peels exhibits the maximum reducing antioxidant activity (EC_{50}= 441.00 µg/ml) while aqueous extract exhibits the minimum antioxidant capacity (IC_{50}= 1134.00 µg/ml).

The results are in agreement with that reported by several authors[30,31-41] for kiwi. The EC_{50} of reducing power antioxidant activity of kiwi fruit ranged from 16 to 256 µg/ml[27]. Rice-Evans et al[30] reported that the kiwi fruit has reducing power ranging from 0.175 to 0.820 absorbance at 700 nm.

In the present study, all the extracts demonstrated considerable ability to chelate metal ions (Fe^{2+}). Kiwi peel ethanol extract exhibits the highest chelating activity IC_{50} (380.72 µg/ml) while acetone extract exhibited low chelating ability (817.86 µg/ml) comparable to EDTA standard (31.43 µg/ml). These results are in concomitant with those reported by Maniyan et al[42] for kiwi. The antioxidant activity of kiwi fruit by Fe^{2+} chelating assay ranged from 6.00 to 11.00% chelation.[42] Also, Bekhradnia et al[27] evaluated the Fe^{2+} chelating activity (IC_{50}) of kiwi fruit methanol extract (174.50 µg/ml) which was higher than our results. These results explained that kiwi fruit contains a high level of vitamin C and strong antioxidant compounds such as carotenoids, lutein, phenolic, flavonoids and chlorophyll as previously reported by Cassano et al.[5]

Antimicrobial activity of kiwi peels: The antibacterial and antifungal activities of ethanol and acetone extracts of Kiwi peels are presented in table 6. Both extracts show a zone of inhibition against gram-positive (*Bacillus subtilis* and *Staphylococcus aureus*) and gram-negative bacterial *(Escherichia coli* and *Pseudomonas aeruginosa*), yeasts (*Saccharomyces cerevisiae* and *Candida albicans*) and fungus (*Aspergillus flavus*) at concentrations 400 and 600 ppm. Extract prepared using 80% acetone exhibited higher antimicrobial activity than that of 80% ethanolic extract. Kiwi peels showed better antimicrobial activity against gram-positive with an inhibition zone of 19.82 at 600 ppm acetone extract for *B. subtilis* and 17.65 mm for *St. aureus* at 600 ppm ethanolic extract.

Also, kiwi peels acetone (80%) extract exhibited the maximum antimicrobial activity against gram-negative with an inhibition zone of 19.52 and 19.50 mm for *E. Coli* and *P*

aueginosa respectively and fungus of 17.85 mm for *A. flavus* at a concentration of 600 ppm which was higher than that obtained by Chou et al.[43] They also reported a zone of inhibition 7 to 14 mm against gram-positive, 9 to 13 mm against gram-negative and 7 to 13 mm against fungus for kiwi fruit at concentration 200 µg/ml. The effect of plant constituents can combat human and plant pathogenic bacteria, fungi and viruses without toxic side effects and environmental hazard[44].

Cytotoxicity activity: Cancer is a global health problem with high morbidity and mortality and possesses economic and psychological challenges were reported by Hsieh et al[45] and Moyad and Carroll[46].

Breast (MCF-7) and hepatocellular carcinoma (HEPG-2) cells were used to determine the anticancer effect of the acetone extract of kiwi peels shown in table 7. Kiwi peels do not show effects against breast and hepatocellular carcinoma cells. These results are in controversy with reports of El Zawawy et al[47] that the ethanol extract of kiwi peels shows the antitumor (34.16 %) activity against breast cancer cell line (MCF-7).

Table 2
Minerals content of kiwi peels

Macronutrients	Concentration (ppm)	Micronutrients	Concentration (ppm)
K	2300 ± 1.74	Fe	82.26± 18.77
Ca	2300± 0.08	Cu	6.64 ± 1.14
Na	900 ± 0.02	Zn	9.26 ± 3.31
P	600 ± 0.01	Mn	14.83 ± 4.25
Mg	8200 ± 0.05	----------	-------

Table 3
Total phenol, total flavonoid and total tannin in different solvent extracts of kiwi peels

Sample	Ext.	TP (mg/g DW)	TF (mg/g DW)	TT (mg/g DW)
Kiwi peels	Aqu	15.64^{b} ± 0.12	13.15^{b} ± 0.28	10.78^{b} ± 0.29
	Me.OH	15.72^{b} ± 0.26	13.12^{b} ± 0.24	10.85^{b} ± 0.22
	Et.OH	14.68^{c} ± 0.45	11.69^{c} ± 0.32	14.15^{c} ± 0.02
	Ace	24.54^{a} ± 0.21	24.47^{a} ± 0.28	16.76^{a} ± 0.26

The unshared letters are significant at p≤0.05.
(Ext): extract, (Aqua): aqueous, (Me.OH): 80% methanol, (Et.OH): 80% ethanol and (Ace): 80% acetone extract.

Table 4
Quantification of the main phenolic compounds presents in 80% acetone extracts (mg/100gDW) by HPLC.

Phenolic compounds	mg/100 g DW
Gallic acid	25.62
Protocatechuic acid	-
Gentisic acid	-
Catechin	26.66
Chlorogenic acid	-
Caffeic acid	1.45
Syringic acid	197.72
Vanillic acid	-
Ferulic acid	9.68
Sinapic acid	-
Coumarin	0.79
Cinnamic acid	-
Rosmarinic acid	-
Chrysin acid	120.40
Ellagic acid	17.19
Tannic acid	-
Pyrogallol	-
Quercetin	84.45
Rutin	-
Acacetin	-
Oleuropein	-

Table 5
Antioxidant activity of various extracts from kiwi plan s.

Sample	Ext	IC_{50} µg/ml			EC_{50} µg/ml
		DPPH·	**ABTS·+**	**Fe^{2+}**	**RP**
Kiwi peels	Aqu	$108.98^{a} \pm 9.02$	$195.01^{e} \pm 1.15$	$736.37^{c} \pm 4.10$	$1143.00^{a} \pm 12.02$
	Me.OH	$89.42^{b} \pm 4.11$	$355.19^{a} \pm 5.70$	$622.11^{d} \pm 6.31$	$860.00^{c} \pm 2.60$
	Et.OH	$107.00^{a} \pm 9.02$	$257.67^{b} \pm 1.55$	$380.72^{f} \pm 10.68$	$925.00^{b} \pm 6.61$
	Ace	$54.85^{c} \pm 1.46$	$22.02^{g} \pm 0.23$	$817.86^{a} \pm 7.17$	$441.00^{f} \pm 5.73$
BHT as standard		$4.73^{d} \pm 0.72$	$15.43^{e} \pm 0.19$	-	$29.00^{e} \pm 0.72$
EDTA as standard		-	-	$31.43^{e} \pm 0.19$	-

The unshared letters are significant at $p \leq 0.05$.
(Ext): extract, (Aqua): aqueous, (Me.OH): 80% methanol, (Et.OH): 80% ethanol and (Ace): 80% acetone extract.

Table 6
Antimicrobial activity of kiwi peels extract.

Extracts	Conc. µg/ml (ppm)	Zone Inhibition (mm)						
		Bacteria				Fungus	Yeast	
		B. subtilis **(+)**	***St. aureus*** **(+)**	***E. coli*** **(-)**	***P. aeruginosa*** **(-)**	***A. fluves***	***S. cerevisiae***	***C. albicans***
Ethanol 80%	200	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	400	13.20	11.30	10.23	10.23	11.70	12.40	11.67
	600	18.16	17.65	18.15	18.15	16.56	17.66	15.25
Acetone 80%	200	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	400	14.16	11.73	13.12	12.56	10.10	11.62	10.87
	600	19.82	15.50	19.52	19.50	17.85	16.81	16.52

Table 7
Cytotoxic activity of kiwi peels acetone extract (80%) at a concentration (100µg/ml).

Samples	MCF- 7 (% cytotoxicity)	HEPG-2 (% cytotoxicity)
Kiwi peels	0.00	0.00
DMSO	3.00	1.00
Negative control	0.00	0.00

MCF- 7: Breast cell line
HEPG-2: Hepatocellular carcinoma cells

Conclusion

1. The acetone extract of kiwi peels possessed antioxidant and antimicrobial activities, hence acetone might be a good solvent for extraction of kiwi peels.

2. Peels of kiwi fruit can be used as good ingredients in the formulation of antioxidant and antimicrobial sources for food products. Further studies are recommended for the isolation of bioactive constituents and biological assay methods for drug preparations.

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