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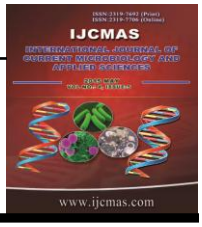

Original Research Article

Antioxidant, Antitumor, Antimicrobial Studies and Quantitative Phytochemical Estimation of Ethanolic Extracts of Selected Fruit Peels

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A B S T R A C T

This study aimed to evaluate the antioxidant, antitumor, antimicrobial activities and phytochemicals of ethanolic fruit peel extracts (orange, lemon, tangerine, watermelon, kiwi, carrot, banana and goldenberry) as fruit peels have been a valuable source for maintaining human health. Free radical scavenging activity of the peel extracts was evaluated by using the DPPH (1, 1-Diphenyl-2 -picryl hydrazyl) method. The antitumor activity of breast cell line (MCF-7) was determined by the Sulphorhodamine-B (SRB) assay. The antimicrobial efficacy was determined using hole plate method against eight pathogenic microorganisms. Also, phytochemical estimation of the extracts was performed using standard methods. The results showed that carrot and watermelon peels give the highest free radical inhibition. Moreover, they showed highest tumor inhibition of the breast cell line. Most of ethanolic peel extracts were found to be active against the tested strains. Overall maximum extracts showing the antibacterial activity range from 1 to 8.5 cm and maximum extracts showing an antifungal activity range from 2.5 to 8.5 cm. Alkaloids were not found in all peels, whereas phenolics, carotenoids, saponins, flavonoids, tannins were found in most of the tested extracts. The obtained results suggest that carrot and watermelon extracts have the highest antioxidant and antitumor activities. The lemon peel extract has the best antibacterial activity, while the banana peel extract has the best antifungal activity. They all contain pharmacologically active compounds and thus provide the scientific basis for the traditional uses of the studied peels in the treatment of fungal and bacteria infections.

Keywords

Fruit peels, Natural antioxidants, Breast cancer, Phytochemicals

Introduction

Fruit peels have been a valuable source for maintaining human health. The use of fruit peel extracts for antimicrobial properties can be of great significance in therapeutic treatments. Fruits by-products such as seeds, peels, stems, barks and leaves usually been discarded and currently the cause of a serious disposal problem in food and agricultural industries (Ghasemi *et al.*, 2009). Therefore, extensive researches on utilizing these wastes are being carried out worldwide.

The peel was found to contain much higher beneficial compounds that possessed antioxidant capacities compared to other fruit parts (Lim *et al.*, 2006).

The natural bioactive compounds in fruits such as carotenoids, quercetin derivatives, phenolic acids and saponins are originally found in the peels with higher concentration towards the flesh (Goulas and Manganaris *et al.*, 2012). Recent studies confirmed the substantially higher amount of phenolic compounds and ascorbic acids in the peel than in the pulp of most of the fruits. Jeong *et al.* (2004) claimed that the peel usually contains higher bioactive compounds in order to protect the inner materials from deterioration by insects and microorganism.

The importance of natural bioactive compounds has led to the development of a large and potential market for natural sources in pharmaceutics and food products Polyphenols in the plants considered to be free natural radical defense that were acknowledged to be beneficial for human health as an antioxidant, antitumor, and anti-microbial agent (Ighodaro, 2012).

The aim of this study is to highlight some biological activities of ethanolic extracts of the selected fruit peels. In essence, we quantified the phytochemical content and determined *in vitro* antioxidant, antitumor activities and their potential as bacterial and fungal inhibitors.

Material and Methods

Collection of fruit peels

Citrus sinensis (orange), *Citrus reticulata* (tangerine), *Citrus Limon* (lemon), *Citrullus lanatus* (watermelon), *Musa acuminata* (banana), *Actinidia deliciosa* (kiwi), *Daucus carota* (carrot) and *Physalis peruviana* (goldenberry) fruits were purchased from a well known market in Tanta city, Gharbia Governorate, Egypt and identified according to Ahmed, 2003. Fruit peels were extracted with ethanol.

Method of extraction

The fruits were cleaned and peeled, and then the peels were freeze-dried and grinded into fine powder using an electric blender. The powder was dried in an oven at 40°C for 24 h. The fine powder sample (2000mg) was extracted in 100 ml ethanol for 24 h using a shaker, then the extract was filtered and the samples were stored at 4°C until use (Sumathy and Sumathy, 2011)

Determination of antioxidant activity

Diphenyl picryl hydrazyl (DPPH) radical scavenging assay

DPPH stable free radical scavenging activity was determined by the method of Blois, 1985. Three ml of each ethanolic fruit peel extract (2 mg/ml) was added to 1ml of a 0.1 mm solution of DPPH in methanol. After incubation at 37°C for 30 min, absorbance was measured at 517 nm against control using a spectrophotometer (Hitachi).

Ascorbic acid was used as the reference materials. The percentage of inhibition was calculated by comparing the optical density values of the extract with those of the controls.

Determination of antitumor activity

Breast carcinoma cell line "MCF-7" was obtained frozen in liquid nitrogen (-180 °C) from the American Type Culture Collection. The antitumor activity of fruit peel extracts against this cell line was measured at the National Cancer Institute, Cairo, Egypt.

Sulphorhodamine-B (SRB) assay of cytotoxic activity

The sensitivity of the human tumor cell line of fruit peel extracts and thymoquinone as a standard drug (50 µg/ml) was determined by the SRB assay, according to that of Shekan and Storeng (1990).

Microbial strains

Bacterial cultures of *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*, yeast cultures of *Candida albicans* and fungal cultures of *Aspergillus niger*, *Aspergillus flavus*, *Penicillium digitatum* and *Fusarium oxysporum* (Human pathogenic clinical isolates) were obtained from the Laboratory of Microbiology, Botany Department, Faculty of Science, Tanta University. The strains were maintained on agar slants at 4 °C and activated at 37 °C for 24 h on nutrient agar (NA) for bacteria and on Sabouraud's dextrose agar (SDA) for yeast, while, fungi were activated at 29°C for 4 days on SDA media before any susceptibility test.

Determination of antifungal activity

Fungal spores were prepared by the method of Guleria and kumar (2006). Spores were isolated from the 10 days old culture of the above mentioned selected fungal cultures by flooding culture plates with 5 ml of sterile distilled water and spores were dislodged by using L-shaped plates. Spore suspension was then prepared in liquid SDA media to obtain a concentration of 3x 10^5 spore/ml. To determine the antifungal activity of fruit peel extracts, the agar-well diffusion method was followed in which the fungal spore suspension was spread on (SDA) solid plates. Regular wells were made in the inoculated agar plates by a sterile cork borer with a 0.8cm diameter. Each well was aseptically filled up with 100µL from each extract of 20mg concentration. The plates inoculated were incubated at 29°C for 4 days. After incubation, the diameter of inhibition zones (DIZ) was measured. Three replicas were made for each tested extract.

Determination of anticandidal and antibacterial activities

An agar well diffusion method was employed in anticandidal and antibacterial activities of each fruit peel according to Prashanth *et al.* (2001). Candida and all bacteria were suspended in sterile water and diluted to 10^6 CFU/ml. The suspension (100µL) was spread onto the surface of SDA and NA media respectively. Wells (of 0.8 cm in diameter) were cut from the agar with a sterile borer and 100µL extract solutions of 20mg concentration were delivered into the wells. The inoculated plates were incubated at 37°C for 24 h. The antibacterial activity was evaluated by measuring the diameter of the inhibition zone (DIZ) of the tested bacteria and the DIZ was expressed in centimeters. All tests were performed in triplicates.

Different concentrations from the highest fruit peels extract against microorganisms (10, 20, 30, 40, 50, 60, 70, 80 mg) were tested with NA broth or SDA broth and colony forming units were counted to determine the minimum inhibitory concentration (MIC) according to Radhika *et al.* (2008). The minimal inhibitory concentration (MIC) of the extract was found to be the lowest concentration of the extract giving the highest inhibitory effect on microorganism. Chloramphenicol and fluconazole with the same concentrations served as a positive control for bacteria and fungus respectively to determine the sensitivity of each microbial species.

Qualitative analysis of secondary metabolites

Fruit peel extracts were subjected to preliminary screening for the presence of secondary metabolites (alkaloids, saponins, carotenoids, flavonoids, tannins and phenolics) by using standard procedures (Trease and Evans, 1989) with some modifications by Sazada *et al.* (2009).

Quantitative analysis of secondary metabolites

Estimation of total phenolic compounds

Phenolic compounds were extracted from each fruit peel extract according to the method outlined by Jindal and Singh, 1975. One gm of powdered extract was extracted with 80 % aqueous ethanol and centrifuged at 3000 rpm for 20 min. One ml of the sample was mixed with 1 ml of Folin-Ciocalteau phenol reagent and one ml of 20% anhydrous sodium carbonate, and then completed up to 5 ml with distilled water. The optical density of the blue color was measured after 30 min. at a wavelength of 650 nm against water-reagent blank. The phenolic content was obtained from a standard curve of pyrogallol and then calculated as mg phenolic per gram dry weight.

Estimation of the total flavonoids

The aluminium chloride colorimetric technique was used for the flavonoids estimation (Chang *et al.*, 2002) Each fruit peel extract (0.5 ml of 1:10 g /ml) in methanol was separately mixed with 1.5 ml of methanol, 0.1 ml of 10% aluminium chloride, 0.1 ml of 1 M potassium acetate and 2.8 ml of distilled water. It was left at room temperature for 30 min, afterwards, the absorbance of the reaction mixture was measured at 416 nm with a double beam UV/Visible spectrophotometer. The total flavonoids content was obtained from a calibration curve, which was plotted by preparing the quercetin solutions at concentrations of 12.5 to 100 g/ml in 90 % methanol.

Estimation of the total Saponins

The method of Obdoni and Ochuko (2001) was used. 20 g from each fruit peel was put into a conical flask and 100 ml of 20% aqueous ethanol was added. The samples were heated on a water bath for 1 h with continuous stirring at 55°C. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extracts were reduced to 40 ml over a water bath at about 90°C. The concentrate was transferred into a conical flask of 250 ml and 20 diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. This process was repeated and 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous chloride. The remaining solution was heated in a water bath. After evaporation, the samples were dried in the oven to a constant weight and the saponin content was calculated in percentage.

Estimation of tannins

Each fruit peel extract (0.5 g) was extracted with 300 ml of diethyl ether for 20 hours at room temperature. The residue was boiled for 2 h with 100 ml of distilled water, left to cool and was then filtered. The extract was adjusted to a volume of 100 ml in a volumetric flask. The content of tannins in the extract was determined colorimetrically by using Folin Denis reagent, and measuring the absorbance of the blue complex at 760

nm, using a tannic acid solution as a standard solution (Chanwitheesuk *et al.*, 2005)

Estimation of carotenoids

About 5g of each fruit peel powder was extracted with 10 ml of 95% ethanol and incubated at 50° C for 60 min until the extraction phase was colorless. The final volume of the carotenoids extract was adjusted to 75 ml by adding 95% ethanol. The optical density value of the carotenoids extract was determined by UV-vis spectrophotometer at 450 nm. The total carotenoids yield (µg/g dry weight) was calculated according to Tao *et al.* (2008) formula as follows:

Carotenoids yield (µg /g dried weight) = V (A-0.0051) / 0.175w

Where, A is the absorbance value of the diluted extraction at 450nm. V is the final volume of the extract, 0.175 is the extinction coefficient of carotenoids and W (g) is the weight of dried powder.

Statistical analysis

All results were expressed as mean values ± standard deviation. Comparisons were performed by analysis of variance (ANOVA). Statistical analyses were run using SAS software.

Result and Discussion

The antioxidant activities of different fruit peel extracts were measured by the ability to scavenge DPPH free radicals and compared with the ascorbic acid as standard. It was observed from the table 1 that the carrot extract at a concentration of 2 mg/ml showed a higher activity than ascorbic acid, followed by the watermelon. The highest scavenging activity were found in carrot and watermelon extracts, followed by goldenberry and banana extracts, while lemon and kiwi extracts showed moderate scavenging activity, followed by tangerine and orange extracts. This study also showed that the carrot and watermelon extracts had significantly higher proton donating ability and could serve as free radical inhibitors or scavenging, possibly acting as primary antioxidants.

Cytotoxicity of ethanolic fruit peel extracts at concentrations of 50 µg/ml on human breast carcinoma cell line MCF-7 was detected by measuring the percentage of cell viability using the SRB assay method. Results depicted in table 2 summarized the cytotoxic effect of different fruit peel extracts and thymoquinone as a positive control. Carrot and watermelon extracts seemed to be highly significant at $P<0.001$ as they showed the highest cytotoxic activity on the tested cell line followed by goldenberry and banana.

While kiwi and lemon showed moderate cytotoxic activity compared to thymoquinone followed by tangerine and orange.

Antifungal activities

There was a significant variation in the antifungal activities (DIZ) of different fruit peel extracts. For *A. niger*, the DIZ values were between 6 and 8.5 cm, only 4 extracts were inhibitory for this fungus, the highest inhibitory one was the banana extract. In the case of *A. Flavus*, the DIZ values recorded were between 1.5 and 6.5cm. A high effect was noted only for the carrot extract, followed by banana, kiwi and goldenberry extracts. For *P. digitatum*, the inhibitory effects were recorded only by 4 ethanolic extracts of the banana, kiwi, carrot and

goldenberry. DIZ values were 8, 6, 6 and 6 cm respectively. In the case of *F. oxysporum*, the DIZ values of eight ethanolic extracts were between 5.5 and 8.5 cm. The maximum inhibitory effect was recorded in the kiwi extract; however, the watermelon and tangerine extracts had a much less inhibitory effect. The results of different fruit peels on *Candida albicans* showed some variation. A weak anticandidal effect was recorded for banana, kiwi and watermelon, followed by carrot and less effect was recorded in the other 4 extracts. The results of these extracts are presented in table 3.

Antibacterial activities

In the present study, the antibacterial effect of the different fruit peel extract was studied on three diverse bacteria were shown in table 3. For *E. coli*, the DIZ values were between 1.5cm and 3.5cm. The highest inhibitory effect was recorded for the lemon extract. Yet for orange, lemon and banana extracts, high antibacterial activity was recorded for *S. aureus*, followed by the watermelon extract, while no activity was recorded for the other four extracts.

The antibacterial effect recorded for *P. aeruginosa* was quite different from other bacteria. In this case of bacteria, lemon and kiwi extracts showed the highest antibacterial effects, followed by watermelon and banana extracts. While, goldenberry, orange and tangerine extracts showed the least inhibitory effect, followed by the other two extracts.

Results of MIC were represented in figure 1. The data indicated that the extracts exhibited varying levels of antimicrobial activity against the investigated microorganisms. The inhibitory properties of the most effective extracts were observed within a range of concentrations from 10 to 80 mg/ml. The maximum activity of the orange extract was observed against *F. oxysporum* and *S. aureus* with MIC of 30 and 20 mg/ml respectively. Also, the lemon extract was observed against *F. oxysporum, P. aeruginosa* and *S. aureus* with MIC of 30, 20, 20 mg/ml respectively. Moreover, the banana extract was observed against *F. oxysporum, S. aureus, P. digitatium* and *A. niger* with MIC of 20, 30, 30 and 20 mg/ml respectively.

F. oxyporum, A. niger and *S. aureus* showed high susceptibility to kiwi extract with an MIC of 30, 20 and 20 mg/ml. Furthermore, the goldenberry extract was observed against *F. oxysporum* and *A. niger* with MIC 30 and 20 mg/ml. While *A. Flavus* showed high susceptibility to carrot extract with an MIC of 30mg/ml. The weak inhibitory effect of fluconazole for fungi and chloramphenicol for bacteria was also observed against all microorganisms with the MIC between 40 to 80 mg/ml, as in figure 1.

The results of the qualitative analysis of fruit peel extracts, as in table 4, showed the absence of alkaloids and the presence of saponins, carotenoids, phenols, flavonoids and tannins in all extracts, while saponins were absent in kiwi extract.

Table 5 represented the quantitative analysis of fruit peel extracts. The contents of the total phenolics and flavonoids measured in the lemon extract were 335 and 10.4 mg/g, thus more significant than in orange and tangerine, followed by the other extracts. Tannins and carotenoid contents of 79.6 and 0.39 g/g were more significant at $P<0.0001$ in carrot extract than in others. However, banana and lemon extracts had higher saponin contents of 0.9 and 0.75 mg/ml respectively.

Several works have been done to evaluate the phytochemical compositions and antimicrobial activities of different parts of diverse fruits, with the aim of using these fruits for the treatment of microbial infection as possible alternatives for synthetic drugs which many infectious microorganisms have developed resistance. The effect of plant constituents can combat human and plant pathogenic bacteria, fungi and viruses without toxic side effects and environmental hazard (Hsieh *et al.*, 2001).

The model DPPH provides a method to evaluate the antioxidant activity in a relatively short time compared to the other methods. In the present study the total ethanol extract of carrot and watermelon peel extracts showed high scavenging activity of DPPH radical in a dose dependent manner with the maximum reactive rates of 92.6 and 89.2 %, followed by goldenberry and banana peel extracts corresponding to 91.8 % for standard ascorbic acid. This was in agreement with Shyamala and Jamuna (2010) who reported that the carrot and watermelon had a high antioxidant activity. Furthermore, goldenberry and banana peel extracts showed high antioxidant activity by Ramadan and Joersel (2007) and Baskar *et al.* (2011).

Drug discovery is the key attempt of our age to overcome many life-threatening diseases such as cancer. Plant extracts that contain several pluripharmacological compounds have been reported to act on multiple molecular and cellular targets, and such approach is gaining support to fight against cancer. The present study identified the peel extracts of carrot, watermelon, goldenberry and banana as a source of antitumor, as well as an anticancer agent. Carrot and watermelon extracts showed cytotoxic activity against breast cancer cell line in which the cell viability decreased to 24.4%, and 29.2% respectively, followed by goldenberry and banana. This was in accordance with the Cai *et al.* (2004) suggested antitumor activity of carrot peels at 28% for breast cancer cell line. Also, Baskar *et al.* (2011) showed a high cytotoxic effect of watermelon peels against the colon cancer cell line. Moreover, Ramadan and Joersel (2007) represented the antitumor activity of goldenberry and banana.

Carrot and watermelon had a wide and complex spectrum of phytochemicals as they contain phenolics, flavonoids, tannins, carotenoids and saponins. These active bioconstituents of carrot and watermelon may constitute potential qualities in its curative action. These records were similar to Shyamala and Jamuna (2010) who showed similar phytochemicals in both extracts. It had been hypothesized that the antioxidant properties of some phytochemicals may protect tissues against oxygen derived from free radicals and lipid peroxidation (Halliwell, 1994) which might be involved in several pathological conditions such as cancer and chronic inflammation (Varghese *et al.*, 2013).

This was in agreement with Saleem *et al.* (2001) who reported that among 37 medicinal plant extracts, *T. chebula* fruit extract had higher phenolic and tannins contents and a higher antioxidant and anticancer activity. This means that antioxidants are known to play a key role in reducing cancer cell proliferation as in carrot and watermelon peels extract.

The present survey represented that some peel extracts such as *Musa acuminata, Actinidia deliciosa Daucus carota and physalis peruviana*, possessed antifungal activity against *A. niger*, *P.digitatum*, *A. flavus* and *Candida albicans.*

Table.1 Antioxidant activity (radical scavenging effect) of some fruit peels, in comparison to ascorbic acid at a concentration of 2 mg/ml

Tested material	Inhibitory percentage of DPPH radical (%)
Ascorbic	91.86±0.058
Orange	41.40±0.10
Tangerine	50.66±0.25
Lemon	56.26±0.15
Watermelon	89.16±0.05
Banana	69.56±0.11
Kiwi	53.50±0.10
Carrot	92.46±0.11
goldenberry	70.40±0.10
F	67031.85
P-value	<0.001**

** P value is statistically highly significant at the 0.001 level.

Table.2 Anti-tumor activity of some fruit peel extracts against breast cancer cell line (MCF-7), in comparison to the commercially available thymoquinone anti-tumor drug at a concentration of (50µg/ml)

Tested material	Percentage of cell viability (%)
Thymoquinone	23.70±0.10
Orange	57.83±0.05
Tangerine	50.03±0.05
Lemon	35.03±0.05
Watermelon	29.20±0.10
Banana	32.60±0.10
Kiwi	34.16±0.05
Carrot	24.40±0.10
Goldenberry	31.20±0.10
F	55465.47
P-value	<0.001**

** P value is statistically highly significant at the 0.001 level

Table.3 Antimicrobial activity of 20 mg/ml ethanolic extracts of different fruit peels

Fruit peels	Diameter of inhibition zone (cm)							
	A.niger	*A.flavus*	*P. digitatum*	*F.oxysporum*	*C. albicana*	*E. coli*	*S. aureus*	*p aerginosa*
Orange	0.00	0.00	0.00	6.00±1.00	0.00	0.00	8.50±0.50	1.50±0.50
Tangerine	0.00	0.00	0.00	5.50±0.50	0.23±0.05	0.00	0.00	0.53±0.05
Lemon	0.00	0.00	0.00	6.00±1.00	0.23±0.05	3.50±0.50	8.50±0.50	8.53±0.05
Watermelon	0.00	0.00	0.00	5.50±0.50	0.73±0.05	3.00±1.00	1.93±0.05	3.63±0.05
Banana	8.66±0.28	2.50±0.10	8.00±1.00	7.53±0.05	0.73±0.05	1.50±0.50	8.50±0.50	3.00±1.00
kiwi	7.00±1.00	2.53±0.05	6.33±0.57	8.66±0.28	0.73±0.05	0.00	0.00	8.50±0.50
Carrot	5.50±0.50	6.53±0.05	6.00±0.50	6.33±0.57	0.53±0.05	0.00	0.00	0.00
Goldenberry	7.50±0.50	1.53±0.05	6.00±0.50	6.66±0.57	0.00	0.00	0.00	2.33±0.57
F	233.62	6214.64	167.24	8.76	124.57	35.42	575.33	143.24
P-value	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**

** P value is statistically highly significant at the 0.001 level.

Table.4 Qualitative phytochemical estimation for selected fruit peels

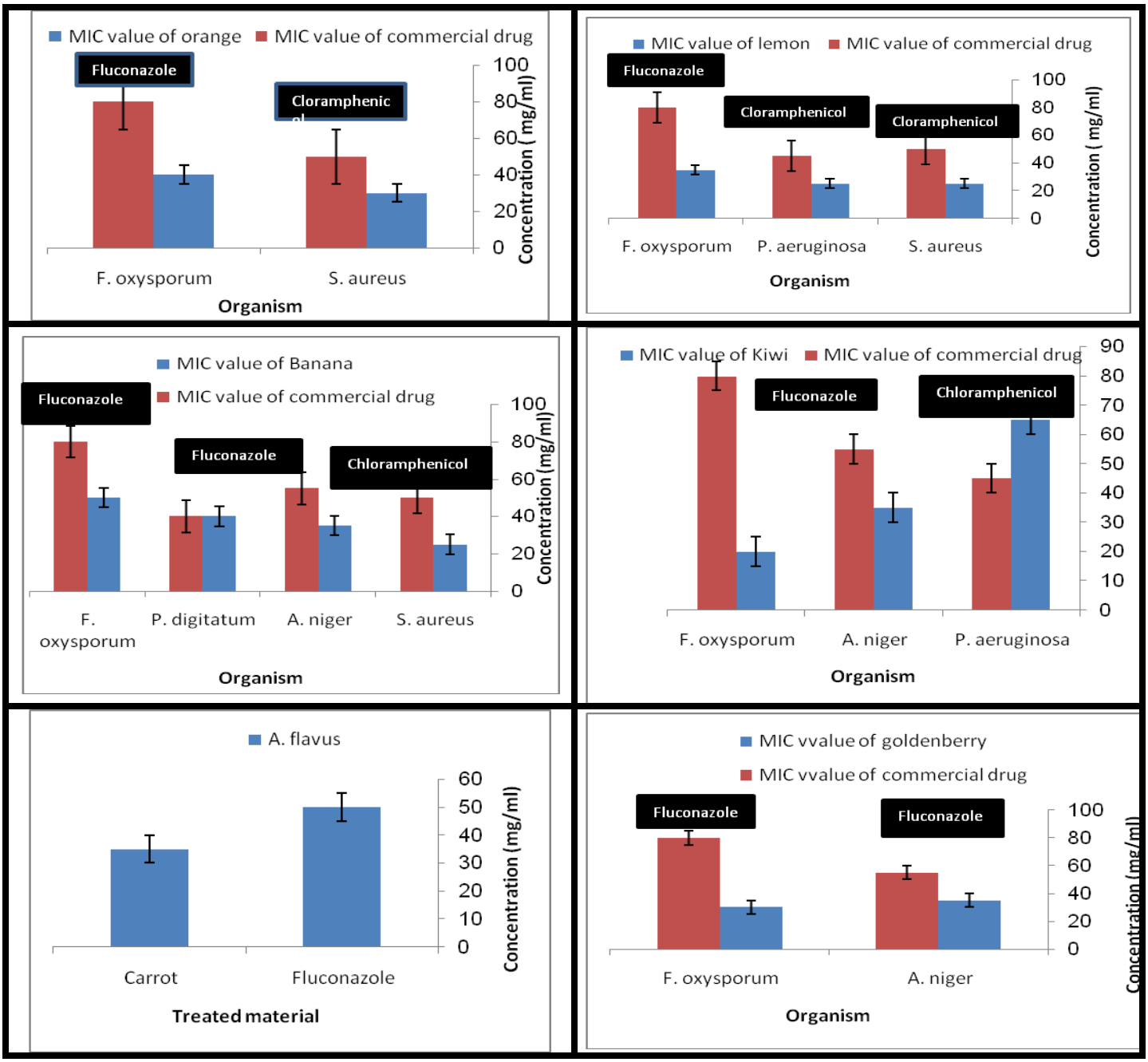
Component	Fruit peels							
	Orange	Tangerine	Lemon	Watermelon	Banana	Kiwi	Carrot	goldenberry
Saponins	+ve	+ve	+ve	+ve	+ve	-ve	+ve	+ve
Carotenoids	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Phenolics	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Flavonoids	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Alkaloids	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Tannins	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve

Table.5 Quantitative phytochemical estimation for selected fruit peels

Fruit peels	Component concentration (mg/g)				
	Saponins	Carotenoids	Phenolics	Flavonoids	Tannins
Orange	0.23±0.05	0.22±0.01	334.83±0.05	4.63±0.05	41.70±0.10
Tangerine	0.22±0.00	0.28±0.01	304.03±0.058	4.89±0.01	41.76±0.05
Lemon	0.75±0.00	0.09±0.00	335.00±0.10	10.43±0.05	48.13±0.05
Watermelon	0.25±0.00	0.34±0.00	70.20±0.10	1.29±0.00	45.70±0.10
Banana	0.93±0.05	0.09±0.00	142.50±0.10	0.45±0.00	50.60±0.10
Kiwi	0.00	0.37±0.00	78.60±0.10	0.06±0.00	60.20±0.10
Carrot	0.33±0.05	0.39±0.01	71.20±0.10	0.70±0.00	79.63±0.05
Goldenberry	0.34±0.00	0.09±0.00	166.25±0.05	0.64±0.01	55.60±0.100
F	221.01	1097.12	5717308.52	44623.28	63688.39
P-value	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**

** P value is statistically highly significant at the 0.001 level.

Figure.1 MIC values (mg/ml) of the most effective fruit peels against tested microorganisms in incomparison to commercial drug



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References

Ahmed, D. 2003. Current situation of the flora and vegetation of Nile Delta region. M.Sc. thesis, Faculty of Science, Tanta University, Egypt.

Al Naimy, E., Al Lihaibi, R., Majeed, S., Al Ani, R. 2012. Antibacterial and cytotoxic effects of kiwi fruit and pomegranate active compounds on tumor cell line (L_2Ob, RD). *Iraqi J. Agricult. Sci.,* 43: 157–167.

Balch, J., Balchi, P. 2000. Prescription for nutritional healing. Penguin Putnam Inc., 16: 267-270.

Baskar, R., Shrisakthi, S., Sathy, B. 2011. Antioxidant potential of peel extract of bannana variétés. *Food Nutr. Sci.,* 2: 1128–1133.

Blois, M. 1958. Antioxidant determinations by the use of a stable free radical. *Nature,* 29: 1199–2000.

Cai, Y., Luo, Q., Sun, M. 2004. Antioxidant activity and phenolic content of 112 traditional chinesse medical plants associated with anticancer. *Life Sci.,* 74: 2157–2184.

Chang, C., Yang, M., Wen, H., Chern, J. 2002. Estimation of total flavonoid content in propolis by two complementary colorimetric methods. *J. Food Drug Anal.,* 10: 178–182.

Chanwitheesuk, A., Teerawutgulrag, A., Rakariyatham, N. 2005. Screening of antioxidant activity and antioxidant compounds of some edible plants of Thailand. *Food Chem.,* 92: 491–497.

Dhanavade, M., Jalkute, C., Ghosh, J. 2011. Study antimicrobial activity of lemon peel extract. *Br. J. Pharmacol. Toxicol.,* 3: 119–122.

Ekam, V., Ebong, P. 2007. Serum protein and enzymes levels in rats following administration of antioxidant vitamins during caffeinated and non caffeinated paracetamol induced hepatotoxicity. *Niger. J. Physiol. Sci.,* 22: 65–68.

Ghasemi, K., Ghasemi, Y., Ebrahimzadeh, M. 2009. Antioxidant activity, phenol and flavonoid contents of 13 citrus species peels and tissues. *Pak. J. Pharm. Sci.,* 22: 277–281.

Goulas, V., Manganaris, G. 2012. Exploring the phytochemical content and the antioxidant potential of Citrus fruits grown in Cyprus. *Food Chem.,* 131: 39–47.

Guleria,, S., Kumar, A. 2006. Antifungal activities of some himalayan medicinal plants using direct bioautography. *J. Cell Mol. Biol.,* 5: 95–98.

Halliwell, B. 1994. Free radicals, antioxidants, and human disease: curiosity, cause, or consequence. *Lancet,* 344: 721–724.

Hsieh, P., Mau, J., Huang, S. 2001. Antimicrobial effect of various combinations of plant extracts. *Food Microbiol.,* 3: 135–43.

Ighodaro, O. 2012. Evaluation study on Nigerian species of *Musa paradisiaca* peels: phytochemical screening, proximate analysis, mineral composition and antimicrobial activities. *Researcher,* 4: 17–20.

Jeong, S., Kim, S., Kim, D., Jo, S., Nam, K., Lee, S. 2004. Effect of heat treatment on the antioxidant activity of extracts from citrus peels. *J. Agric. Food Chem.,* 52: 3389–3393.

Jindal, K., Singh, R. 1975. Phenolic content in male and female Caricapapaya: A possible physiological marker for sex identification of vegetation seedlings. *Physiol. Plant,* 33: 104–107.

Jisika, M., Ohigashi, H., Nogaka, H., Tada, T., Hirota, M. 1992. Bitter steroid glycosides, Vernon sides A1, A2, and A3 and related B1 from the possible medicinal plant *vernonia amygdalina* used by wild

Chimpanzees. *Tetrahedron,* 48: 625–630.

Lim, Y., Lim, T., Tee, J. 2006. Antioxidant properties of guava fruit: comparison with some local fruits. *Sunway Acad. J.,* 3: 9–20.

Mathur, A., Vema, S., Gupta, V. 2011. Evaluation of *in vitro* antimicrobial and antioxidants of peel and pulp of some citrus fruits. *J. Biotechnol. Biotherap.,* 2: 12–17.

Obdoni, B., Ochuko, P. 2001. Phytochemical studies and comparative efficacy of the crude extracts of some Homostatic plants in Edo and Delta States of Nigeria. *Global J. Pure Appl. Sci.,* 8: 203–208.

Prashanth, D., Asha, M., Amit, A. 2001. Antibacterial activity of *Punica granatum*. *Fitoterapia,* 72: 171–173.

Puente, L., Muñoz, C., Castro, E., Cortés, E. 2011. *Physalis peruviana Linnaeus*, the multiple properties of a highly functional fruit. *Food Res. Int.,* 44: 1733–1740.

Radhika, P., Sastry, B., Harica, B., Madhu, B. 2008. Antimicrobial screening of *Andrographis paniculata* (Acanthaceae) root extracts. *Res. J. Biotech.,* 3: 62–63.

Ramadan, M., Joersel, M. 2007. Scavenging potential activity of goldenbery. *Mal. J. Nutr.,* 3: 397–408.

Saleem, A., Ahotupa, M., Pihlaja, K. 2001. Total phenolics concentration and antioxidant potential of extracts of medicinal plants of Pakistan. *Zeitschrift Naturforschung,* 56: 973–978.

Sazada, S., Verma, A., Rather, A., Jabeen, F., Meghvansi, M. 2009. Preliminary phytochemicals analysis of some important medicinal and aromatic plants. *Adv. Biol. Res.,* 3: 188–195.

Shekan, P., Storeng, R. 1990. New colorometric cytotoxicity assay for anticancer drug screening. *J. Natl. Cancer Inst.,* 82: 1107–1112.

Shyamala, B., Jamuna, P. 2010. Nutritional content and antioxidant properties of pulp waste from *Daucus carota* and *Betavulgaris*. *Mal. J. Nutr.,* 3: 397–408.

Sumathy, N., Sumathy, J. 2011. Antibacterial and antifungal activity of musa fruit peels against skin and gastrointestinal tract diseases. *Herbal Tech. Indust.,* 2: 9–11.

Tao, N., Zhang, J., Cui, Y. 2008. Studies on microwave extraction of carotenoids from *Fructus lycii*. Natural Science. *J. Xiangtan Univ.,* 30: 48–51.

Trease, G., Evans, W. 1989. Pharmacognosy, 2nd edn, Braille Tiridel and Macmillan publishers.

Varghese, S., Narmadha, R., Gomathi, D. 2013. Phytochemical screening and HPLC finger printing of *Citrullus lanatus*. *J. Acute Dis.,* 13: 122–126.