Phytochemical, Physicochemical and Antioxidant Properties of Orange (*Citrus sinensis* L.) Peel

Myo Min[1], Pyae Phyo Aung[2], May Thi Oo[3]

Abstract

Orange peels are beneficial in management and treatment of several disease conditions. They are rich in multi-vitamins and chemical nutrients. Therefore, the physicochemical and antioxidant properties of orange peel were studied. Firstly, phytochemical investigation of orange peel was carried out by Test Tube method. From the investigation, phytoconstituents such as alkaloids, α-amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch, tannins, and terpenoids were present in the sample. Semi-quantitative elemental analysis of orange peel was performed by EDXRF method. From the analysis, calcium and potassium were present as highest contents in the sample. The nutritional values of orange peel were determined by AOAC methods. From the determination, carbohydrate (65.39%), moisture (12.93 %) and crude fiber (12.50%), protein (3.99 %), fat (2.41%) and ash (2.78%) were observed in the sample. The antioxidant activities of water and ethanol extracts of orange peel were determined by DPPH method. From the screening of antioxidant activity, IC_{50} values of standard ascorbic acid, ethanol and water extract were observed with 5.04, 55.96 and 22.36 µg/mL, respectively. According to the experimental results, the orange peel possesses effective chemical nutrients and antioxidant properties. Therefore, the orange peel may be used in the medicinal formulation.

Keywords: AOAC method, Antioxidant activity, DPPH method, EDX-RF method, Physicochemical properties

I. INTRODUCTION

Orange

The orange is the fruit of the citrus species *Citrus* ×*sinensis* in the familyRutaceae. It is also called sweet orange, to distinguish it from the related *Citrus* × *aurantium*, referred to as bitter orange. The sweet orange reproduces asexually (apomixis through nucellar embryony); varieties of sweet orange arise through mutations. The orange is a hybrid between pomelo (*Citrus maxima*) and mandarin (*Citrus reticulata*). The chloroplast genome, and therefore the maternal line, is that of pomelo. The sweet orange has had its full genome sequenced. (Xu, *et al*., 2013)

This citrus is known for its sweet fruits. The fruit is ripe when the skin on the fruit is orange.It has oblong to elliptic, glossy leathery dark green foliage and bears clusters of white flowers that bloom in spring. Plant orange trees in a full sun position, they can also tolerate partial shade. Leave oranges on the tree until you're ready to use them, as they do not continue ripening after picking. This fruit tree has oblong to elliptic, glossy leathery dark green foliage. (Webber, *et al*., 2004)

[1]Associate Professor, Department of Chemistry, West Yangon University

Figure 1. Orange plant fruits and peel

Scientific Classification

Kingdom	: Plantae
Order	: Sapindales
Family	: Rutaceae
Genus	: Citrus
Species	: *C. sinensis*
Botanical name	: *Citrus sinensis* L.
English name	: Orange

Plant Description

All citrus trees belong to the single genus Citrus and remain almost entirely interfertile. This includes grapefruits, lemons, limes, oranges, and various other types and hybrids. As the interfertility of oranges and other citrus has produced numerous hybrids and cultivars, and bud mutations have also been selected, citrus taxonomy is fairly controversial, confusing or inconsistent. The fruit of any citrus tree is considered a hesperidium, a kind of modified berry; it is covered by a rind originated by a rugged thickening of the ovary wall. Different names have been given to the many varieties of the genus. Orange applies primarily to the sweet orange – *Citrus sinensis* (L.) Osbeck. The orange tree is an evergreen, flowering tree, with an average height of 9 to 10 m (30 to 33 ft), although some very old specimens can reach 15 m (49 ft). (Willard. 2012)

Nutritional and Health Benefits of Orange Peel

Orange peels are beneficial in management and treatment of several disease conditions. They are rich in Vitamin C, A, B5, B6, calcium, Iron, magnesium, zinc, copper, potassium, phosphorous Pigments, B-Carotene. Orange peels contain hespetidin, a compound known for its antioxidant properties. It is also found in orange pulp but in much lower amount. Hespetidin helps in lowering the cholesterol level of the body and maintain the blood pressure. Orange peel contains pectin, a natural fiber which prevents problem like constipation and maintains the blood sugar level. Pectin also helps in promoting the growth of good bacteria in the intestine which results in better digestion. (Sree, 2013)

Orange peel contains natural oil which makes the skin elastic, strong and beautiful. This oil acts as natural cleanser this essential oil can be used in soaps and water-less hand cleaners. The oil is a solvent, so it can effectively clean skin without the use of hazardous chemicals. Orange oil is also used as a scent in perfumes and cleaning products. Tea prepared from the orange peel is an excellent remedy for weight loss. It increases metabolism, removes fat from the body and increases the body energy and stamina. It is also an excellent remedy for insomnia. (Sree, 2013)

Orange peels are a boon for skin, as they possess anti-microbial, anti-inflammatory and anti-fungal properties. The dried peels can be powdered and used to

scrub and exfoliate skin. It is a great cleanser, helps to cure acne and pus filled pimples and remove blackheads, dark spots and pigmentation. Orange peel acts as natural sunscreen. It contains d-limonene which works as a shield to UV rays of sun. Rubbing orange peel on skin gives additional benefits like prevention from acne and premature aging. Orange peels contain anti-inflammatory nutrients which help in fighting haemorrhoids and even cancer. Orange peels also contain flavonoids which De-accelerate the growth of cancer cells. (Sree, 2013)

While orange peels have several health benefits, they are prone to accumulation of chemicals and pesticides which are rampantly used in horticulture today. Also on several occasions there are chemicals like wax, rubbed on the surface of the oranges to make them look healthier and fresh. Taking orange peels is a great way of safeguarding the body and skin from the host of common infections and allergies. (Sree, 2013)

II. AIM

To apply the orange peel which possesses effective nutrients and antioxidant activities and to reduce the agricultural waste.

III. EXPERIMENTAL

The orange fruits were collected from Pyin Oo Lwin Township, Mandalay Region, Myanmar. Then, orange fruits were peeled and cut into small piece and air-dried. The peels were powdered by a grinder. The powdered samples of orange peels were stored in air-tight containers. Firstly, preliminary phytochemical investigation of orange peel was carried out by Test Tube method (M-Tin Wa, 1972). Then, semi-quantitative elemental analysis of orange peel was performed by ED-XRF method (Griken *et al*., 1986). Moreover, the nutritional values of orange peel were also studied by AOAC method (AOAC, 2000). The antioxidant activities of water and ethanol extract from orange peel were determined by DPPH method (Merks, 1996).

IV. RESULTS AND DISCUSSION

Preliminary Phytochemical Investigation of Orange Peel

Phytochemical investigation was performed to examine the different types of chemical constituents present in orange peel. The results are shown in Table 1. It is observed that these tests show the presence of alkaloids, α-aminoacid, carbohydrate, glycoside, flavonoids, phenolic compounds, reducing sugars, saponins, starch, tannins and terpenoids in the orange peel samples. Cyanogenic glycosides were not detected in orange peel sample.

Table 1 Results of Preliminary Phytochemical Investigation of Orange Peel

No.	Types of compounds	Extracts	Test reagent	Observations	Remark
1	Alkaloids	1 % HCl	Dragendorff's reagent	Orange ppt	+
			Wagner's reagent	Yellow ppt	+
			Mayer's reagent	White ppt	+
2	α- amino acids	H_2O	Ninhydrin reagent	Violet spot	+
3	Carbohydrates	H_2O	10%α-naphthol and H_2SO_4 (conc)	Red ring	+
4	Cyanogenic glycosides	H_2O	Conc. H_2SO_4 and sodium picrate	No change	-
5	Flavonoids	EtOH	Mg turning and H_2SO_4	Green color	+
6	Glycosides	H_2O	10%Lead acetate	White ppt	+
7	Phenolic compounds	H_2O	5 % $FeCl_3$ solution	Brown ppt	+
8	Reducing sugars	Dil.H_2SO_4	Benedict's solution	Light green	+

				color	
9	Saponins	H_2O	Distilled water	Frothing	+
10	Starch	H_2O	Iodine solution	Red color	+
11	Tannins	H_2O	$FeSO_4$ solution	Green color	+
12	Terpenoids	EtOH	Acetic anhydride and conc. H_2SO_4	Green color	+

+ = present, - = absent

Semi-quantitative Elemental Results of Orange Peel

The elemental compositions of orange peel sample were determined by EDXRF method. The ED-XRF results of orange peel sample shown in Figure 1 and Table 2. It can be seen that organic constituents are predominant in the sample; other elements such as Ca and K were also presented in reasonable composition as inorganic constituents but S, Fe, Cu and Sr were presented in a very small trace amount in the sample. Ca and K are also very important essential elements for the human metabolisms. Ca helps for the teeth and bones to be strong. K reduces the high blood pressure. S is usually used in the medicinal formulation.

Nutrient Values of Orange Peel

The nutritional values and energy value of orange peel samples were determined by AOAC methods. The result of the nutritional contents is shown in Table 3. From the experimental results, the carbohydrate amount was observed as the highest content and moisture and fiber were moderate amounts. Protein, ash and fat were present as the lowest amounts in the orange peel.

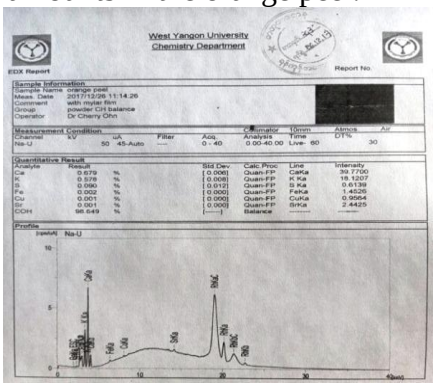

Figure 1 EDXRF results of orange peel sample

Table 2 Elemental Composition of Orange Peel

No.	Analyte	Composition
1	Ca	0.679
2	K	0.578
3	S	0.090
4	Fe	0.002
5	Cu	0.001
6	Sr	0.001
7	COH	98.649

Table 3 Results of Nutrient Values of Orange Peel Sample by A.O.A.C Method

No.	Parameter	% (w/w)
1	Moisture	12.93
2	Ash	2.78
3	Crude fat	2.41
4	Crude fiber	12.50
5	Protein	3.99
6	Carbohydrate	65.39
7	Energy value	299.21 (kcal/ 100g)

Screening of Antioxidant Activity of Orange Peel

The antioxidant activities of water and ethanolic extract of orange peel were determined by DPPH method. Ascorbic acid was used as the standard. The concentration of standard ascorbic acid, water and ethanolic extract of orange peel such as 200 µg/mL, 100 µg/mL, 50 µg/ mL, 25 µg/ mL and 12.5 µg/ mL were prepared to determine the absorbance by UV spectrophotometer. The IC_{50} values of various solutions were calculated from the percent inhibitions at various concentrations. From the screening of antioxidant activity, IC_{50} values of standard ascorbic acid, ethanol and water extract were observed with 5.04, 55.96 and 22.36 µg/mL, respectively. Therefore, it can be seen that the orange peel possesses the antioxidant activity. The antioxidant activity of water extract is more potent than that of ethanol extract. The antioxidant activities of standard ascorbic acid and extract samples of orange peel are shown in Table 4, 5, 6, Figure 2, 3, 4 and 5.

Table 4 Absorbance of Different Extracts of Orange Peel at 517 nm by UV Spectrophotometer

No.	Concentration (µg/mL)	Ascorbic acid (Standard)	Ethanol extract	Water extract
1	12.5	0.220	0.255	0.241
2	25	0.161	0.187	0.173
3	50	0.126	0.186	0.124
4	100	0.059	0.127	0.086
5	200	0.043	0.061	0.043

Table 5 Percent Inhibition of Different Extracts of Orange Peel (DPPH Scavenging Assay Method)

No.	Concentration (µg/mL)	Ascorbic acid (Standard)	Ethanol extract	Water extract
1	12.5	39.89	30.33	34.15
2	25	55.96	48.91	52.84
3	50	65.61	49.18	66.12
4	100	83.88	65.30	76.50
5	200	88.24	83.33	88.14

* Absorbance of DPPH (Control) = 0.366,

$$\% \text{ RSA} = \frac{Abs_{DPPH} - [Abs_{Sample} - Abs_{Blank}]}{Abs_{DPPH}} \times 100$$

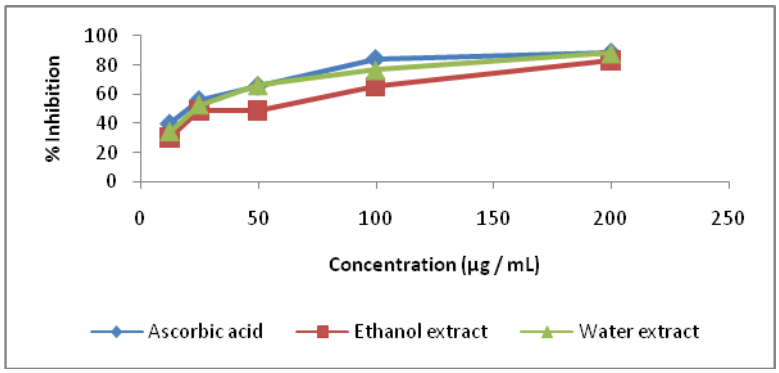

Figure 2 Antioxidant activities of standard ascorbic acid, ethanol and water extract with concentrations

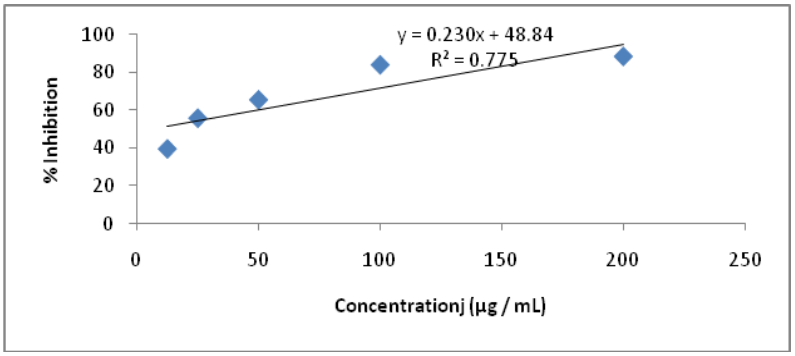

Figure 3 Linear regression equation for antioxidant activity (IC_{50}) of standard ascorbic acid

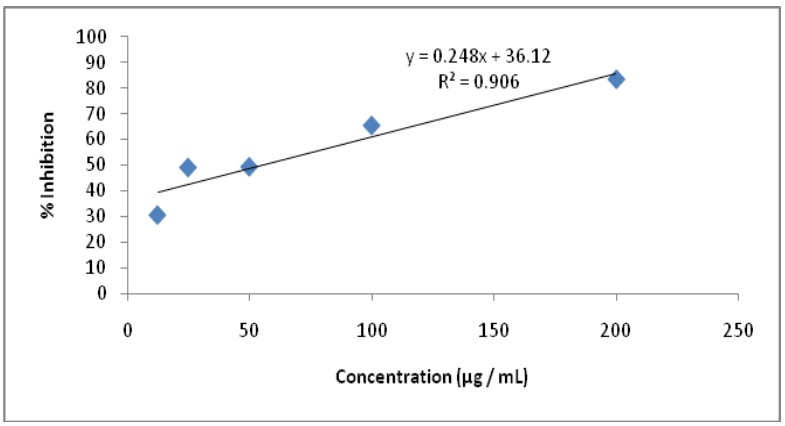

Figure 4 Linear regression equation for antioxidant activity (IC_{50}) of ethanol extract

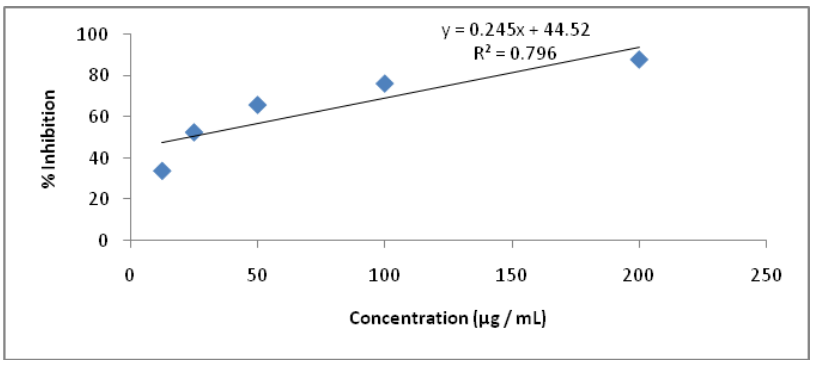

Figure 5 Linear regression equation for antioxidant activity (IC_{50}) of water extract

Table 6 The Regression Equation and IC_{50} Values of Ascorbic acid, Ethanol and Water Extract

No.	Test Solution	Regression Equations	IC_{50} (ppm)
1	Ascorbic Acid	y = 0.230x + 48.84	5.04
2	Ethanol extract	y = 0.248x + 36.12	55.96
3	Water extract	y = 0.245x + 44.52	22.36

V. CONCLUSION

Preliminary phytochemical investigation of orange peel was carried out by Test Tube method. From the investigation, phytoconstituents such as alkaloids, α-amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch, tannins, and terpenoids were present in the sample. These

phytoconstituents are applicable for the use of human health. But cyanogenic glycoside was not found in the sample.

From the study of semi-quantitative elemental analysis by EDXRF method, the elemental compositions of orange peel were determined by EDXRF method. It can be seen that organic constituents are predominant in the sample; other elements such as Ca and K were also present in reasonable composition as inorganic constituents but S, Fe, Cu and Sr were present in a very small trace amount in the sample. Ca and K are also very important essential elements for the human metabolisms. Ca helps for the teeth and bones to be strong. K reduces the high blood pressure. S is usually used in the medicinal formulation.

The nutritional values of orange peel were determined by AOAC methods. From the determination, carbohydrate (65.39%), moisture (12.93 %) and crude fiber (12.50%) were found as high contents and protein (3.99 %), fat (2.41%) and ash (2.78%) as low contents in the orange peel sample. These nutrients are essential for human metabolism. Therefore, the orange peel possesses the energy values, 299.21 kcal/ 100g. As the reasonable energy value, the orange peel may be used as good nutritional diet for human.

The antioxidant activities of water and ethanol extracts of orange peel were determined by DPPH method. The ascorbic acid was used as the standard. The concentrations of test sample solutions were prepared in the range of 200, 100, 50, 25 and 12.5 µg / mL. From the screening of antioxidant activity, IC_{50} values of standard ascorbic acid, ethanol and water extract were observed with 5.04, 55.96 and 22.36 µg/mL, respectively. Therefore, it can be seen that the orange peel possesses the antioxidant activity. The antioxidant activity of water extract is more potent than that of ethanol extract. According to the comparison of IC_{50} values between standard ascorbic acid and orange peel, the orange peel possesses the rich antioxidant activity. Therefore, orange peel may be used in the medicinal antioxidant for human health.

According to the experimental results, the orange peel possesses effective chemical nutrients and antioxidant properties. Therefore, the orange peel may be used in the medicinal formulation of human health.

ACKNOWLEDGEMENTS

We would like to express deep sense of gratitude to Rector Dr. Tin Maung Tun, West Yangon University for his kind provision of the research facilities. We also wish to express our profound gratitude to Dr Sanda Khar, Professor and Head of Chemistry Department, West Yangon University for her encouragement and comment without which this work would not have been completed.

REFERENCES

AOAC. (2000). “Official methods of analysis of the Association of Official Analytical Chemists”. 15th edition. Washington, DC.

Griken, R. V., Markowicz, A., and S. Torok, S. (1986). “Energy DispersiveX-ray Spectrometry”. Department of Chemistry, University of Antwer (UIA), B-2610. Antwerp-wilrijk, Belgium.

M-Tin Wa. (1972). “Phytochemical Screening”, Phytochem. Bulle. Bot., Society of America, Inc., 5(3), 4-10.

Merks, D.B., Marks, A. D., and Smith, C. M. (1996). “Oxygen Metabolism and Oxygen Toxicity”.*Basic Medicinal Biochemistry*, Oxford University Press, 181-185.

Sree. R. (2013). “Nutritional and Health Benefits of Orange Peel”. Department of pharmaceutics. College of pharmaceutical sciences. Sri Krishnadevaraya University. Anantapur. India. (www.pharmaresearchlibrary.com)

Webber, Herbert J., Reuther, Walter and Lawton. (2004). "The Citrus Industry". Riverside, California: University of California Division of Agricultural Sciences.

Willard, H. (2012). “The Citrus Industry, Horticultural Varieties of Citrus”. In Webber, Herbert John; rev Walter Reuther and Harry W. Lawton. Riverside, California: University of California Division of Agricultural Sciences.

Xu Q., Chen L., Ruan X. and Chen D. (2013). "The draft genome of sweet orange (*Citrus sinensis*)". Nature Genetics. 45: 59–66.