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Short Communication

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Quality assessment, sensory evaluation, and radical scavenging activity (RSA) of orange (*Citrus auranthium*) pulp

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Abstract

Oxidative stress is a significant source of the pathogenesis of many chronic diseases; that is why antioxidant behavior is one of the most commonly identified biological activities in citrus fruits. The pulp of citrus fruits is the sticky substance of the fruit's endocarp and contains the fruit's juice. This study scrutinizes the quality assessment, sensory evaluation, and free radical scavenging activity (RSA) of orange (*Citrus auranthium*) pulp. Free radical scavenging activity was examined by 2, 2-diphenyl-1-picrylhydrazyl assay. The quality assessment parameters results showed that the ºBrix of orange pulp was 64.50, pH 3.70, acidity 5.12, ratio 12.58, pulp 9.70%, and SO_2 were not detected. On analyzing the sensory evaluation, it was found that orange pulp juice has the score of appearance (7.07 ± 0.146), color (7.27 ± 0.163), flavor (7.52 ± 0.172), taste (6.87 ± 0.156), and overall acceptability (7.60 ± 0.165). The results of free radical scavenging showed that the percentage inhibition was 9.55-54.80 at concentrations of 0.2-1.0 mg/ml. The antioxidant activity of orange pulp may be due to presence of polyphenols, flavonoids and possibly other compounds in orange pulp that are responsible for this activity.

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Introduction

In the food industry, quality always remains the first preference. Due to various food-related issues, it is increasingly raised as an essential element. The demand for quality food is rising day by day. To compete with this claim for quality food products has distributed the use of high-quality management tools. Food technologists have been working to meet the expectations of the market and customers throughout the world. They are also working to produce safe food products, reducing costs, improving quality and production losses (Dias *et al.*, 2010). The demand for fresh fruits is rapidly increasing. It has also imitated changes in customer preferences for healthier and safe foods, which should be manufactured through environmentally friendly methods. Various diseases are closely associated with eating habits. These diseases include diabetes, atherosclerosis, high blood pressure, cancer etc. In recent times, functional foods have extended popularity because they can eliminate such kind of diet-related diseases (Jayaprakasha *et al.,* 2008; Sipho *et al*., 2020).

Citrus fruits and citrus juices are vital sources of bioactive compounds. These bioactive compounds include various antioxidants such as flavonoids, ascorbic acid, some phenolic compounds and pectin are important source of nutrition for humans. (Jayaprakasha and Patil, 2007; Kamaran *et al*., 2009). Oranges are consumed globally as a good source of these polyphenolic compounds and Vitamin C (Klimczak *et al*., 2007; Sumit and Satya, 2018), which positively impact human health. Therefore, it is beneficial to consume citrus fruits and products derived from these fruits. Orange is a citrus, a high-yielding citrus hybrid widely grown in Punjab, Pakistan. Harvest and post-harvest losses for orange range from 25-30% (Singh *et al*., 2016).

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Fig. 1. Orange (*Citrus auranthium*) and its pulp

The fruit needs to be processed to reduce these losses, and the main processed product of citrus fruit is the fruit pulp, which is generally extracted from the juice by filtration. Fruit pulp juiciness is determined by several factors, including the variety, species, and season in which the fruits are grown.

Free radicals are the atoms or groups of atoms with one or more unpaired electrons (Konan *et al*., 2016). The excessive production of these molecules causes oxidative stress, which leads to many diseases such as hypertension, diabetes, various types of cancer and neurodegenerative diseases (Bairy *et al*., 2016). The study of Epidemiology intensely suggests that consuming fruits and vegetables that have antioxidant properties are protective against these diseases and prevent degenerative processes caused by oxidative stress (Senevirathne *et al*., 2006; Vinson *et al*., 2001; Tang *et al*., 2020). Moreover, the human body can also produce some natural antioxidants such as catalase, superoxide and peroxidase, which deactivate free radicals, but unfortunately, these antioxidants are not enough for our body's needs (Rao *et al*., 2006; Faheem *et al*., 2021). Therefore, it is essential to provide natural antioxidants to humans at a low cost. Therefore, this study endeavored to determine orange pulp's quality assessment and free radical scavenging activity (RSA).

Materials and methods

Chemicals and reagents

DPPH, BHT, Iodine, starch, and NaOH were purchased from Merck and Fluka companies. All other chemicals and reagents used in this research were analytical grade.

Sample preparation

Orange fruit (*Citrus auranthium*) was purchased from a native market in Lahore, Pakistan. It was peeled and the pulp and seeds were removed. The pulp and seeds were carefully separated. The pulp was sealed in plastic bags and kept at -18°C until it was analyzed.

pH, ºBrix, total acidity, ºBrix/acidity ratio and % pulp

The pH was measured at 25°C using a (InoLab pH Level 1, Germany) pH meter (Crison Inst. S.A., Barcelona, Spain) calibrated with a pH 7 buffer solution. Total soluble solids were measured with a digital refractometer (HANNA, Instruments, Romania), and the results are reported in °Brix. The acidity of crushed pulp was assessed using a protocol by titrating 100 mL of orange pulp with NaOH (0.1 N) solution to pH 8.1. The Results were taken in grams of citric acid per 100 g (% w/v) citric acid. The ºBrix/acidity ratio was measured by dividing the brix by pulp acidity. A total of 11.0 g of pulp was mixed with water to make °Brix 12 (18.6 g pulp up to 100 ml), then centrifuged at 3,000 rpm by using a centrifuge machine (Centurarian Scientific (3000 System), for 30 minutes. After that, the residue was measured as pulp percentage and reported in (% w/v) pulp (Bourhia *et al*., 2019). All assays were performed at 25°C, and values are the average of three replicates.

Total and free sulfur dioxide (SO_2)

Based on the discharge of free SO_2 in the occurrence of H_2SO_4, it was titrated with 0.2 N iodine solution. A strong base (1% starch solution) was used as an indicator to examine the SO_2,

Sensory evaluation of pulp

Sensory analysis was performed on a 9-point hedonic scale (Rangana, 1986) by a test panel consisting of 10 panelists and students and staff from the Food FBRC, PCSIR Integrative Laboratory, Lahore. The °Brix 12 juice is first created by adding water, then served in a coded glass. The samples were distributed to the group in random order. Between assessments, group participants were given drinking water to rinse their lips. Instructed panelists to rate the coded samples by indicating their similarity in flavor, taste, color, and overall acceptability on a 9-point Hedonic scale where 9 = extremely like; 8 = very much like; 7= moderately like; 6 = slightly like; 5 = neither like nor dislike; 4 = slightly dislike; 3 = moderately dislike; 2 = very much dislike and 1 = extremely dislike.

Radical scavenging activity (RSA)

The influence of orange pulp extract on 2,2-diphenyl-1-picrylhydrazine (DPPH) free radicals was measured by the method as described by (Yi *et al*., 2008) with some modifications (Saeed *et al*., 2022). Mixed 0.1 mL of extraction solution (0.2-1.0 mg/mL) with 2.9 mL of DPPH (0.004% in methanol). The reaction mixture was incubated at room temperature for 30 minutes. Using a spectrophotometer (UV-Vis - 1700 Shimazdu, Japan), the resulting solution's absorbance was measured at 517nm. The assay was performed similarly, but water was used as a substitute for sample solution to control the experiment. The radical scavenging activity of the test sample was measured as the decrease in absorbance and calculated using the following equation:

Scavenging activity (%) = Ac-As / Ac ×100

While Ac and As, are the absorbance at 517 nm of the control and sample, respectively.

Statistical analysis

For the quality assessment and free radical scavenging activity of orange pulp, the calculation of mean, standard deviation, and coefficient of variation was used. Analysis of variance (ANOVA) was performed on pulp chemistry monitoring and sensory evaluation data.

Results and discussion

Total soluble solids (ºBrix) and pH

The orange pulp's total soluble solids (ºBrix) value was 64.50 ± 2.30 (Table I). There is a significant parameter determining total solubility (Nandhakumar, 2013). The ºBrix scale measures the percentage of soluble dry matter in the pulp. The results show that this pulp is of excellent quality and prevents the pulp from growing bacteria and mold (Mathur *et al*., 2011). The parameter of the pH defines the microbial stability of fruit during the whole process of storage (Hazbavi *et al*., 2013). It also affects the taste of the fruit. The pH of orange pulp is 3.70 ± 0.01 (weakly acidic). The pH of orange pulp reported in our work is slightly higher than that described by Selma *et al*., (2018) (3.61 ± 0.02) and also other fruits, such as grapefruit (3.67 ± 0.03) (Table I) (Cheong *et al*., 2012). pH plays a dual role in pulp juice as both a flavor promoting and preservative factor. Several researchers have demonstrated that a decrease in pH in pulp samples is proportional to an increase in acidity, which may be attributed to the presence of pulp samples (Bajwa *et al*., 2002; Hussain *et al*., 2008).

Total titratable acidity and ºBrix/acidity ratio

The total titratable acidity is the sum of the free-acid functions of the sample and the total titratable acidity value is inversely proportional to the ºBrix value (negative correlation Table I). The average acidity of orange pulp is 5.12 ± 0.13 g citric acid/100 g. The results of the acidity present in the orange pulp of the current study are reliable to those that are reported in the previous literature (Esteve *et al*., 2005).

The Brix/Acidity ratio is an essential indicator for determining the taste and quality of fruit. It is also used to determine fruit ripeness (Bourhia *et al*., 2020). Orange pulp exhibited the highest ºBrix/acidity ratio with 12.58 ± 0.90 (Table I). Therefore, these fruits are considered the best edible fruits due to their taste qualities. Our results are partially equivalent to those of other studies (Susmit and Satya, 2018).

Percentage of pulp and total SO_2

The fruit pulp is a non-concentrated, unfermented, and with no added water product obtained from pulpy fruits by applying a technical process. It contains minimum total solid content from raw edible fruit portions (Josi-Noelline *et al*., 2017). Table I showed that the mean pulp % was 9.70 ± 0.5, indicating that it contains a good quantity of fruit and it has enjoyable effects on nutritional facts. It is the primary food product obtained from the processing of fresh fruits. The pulp of fruits can be cold easily and stored for long times. It can also be used to formulate juices and additional food products (Carlos and Ana Karla, 2017). The result of total and free sulfur dioxide determination showed that the SO_2 was not detected. Sulfate of the products consists of added gaseous sulfuration showed dioxide in the form of aqueous sodium metabisulfite solution. It is the primary process that aims to initiate alcoholic fermentation. This reaction blocks the bacterial activity and inhibits the oxidation of the product (Curvelo-Garcia, 2005).

Sensory evaluation of orange pulp

Sensory evaluation of ready-to-serve orange drinks prepared from the orange pulp was assessed for flavors, taste, color, and complete acceptability. It is clear that the addition of chemical preservatives significantly affects these properties, with a slight loss in pulp quality (Aande *et al*., 2020). One-way ANOVA showed that panelists accepted the entire sample with varying degrees of acceptability. Sensory evaluation of food products plays a vital role in judging sensory acceptance or rejection of food products on the market (Sharma *et al*., 2006; Saeed *et al*., 2014). Quality is the ultimate criterion for all food products, influenced by sensory qualities such as appearance, color, texture, flavor, and taste (Jothi *et al*., 2014). Table II presents the results of the study on appearance (7.07 ± 0.146), color (7.27 ± 0.163), flavor (7.52 ± 0.172), taste (6.87 ± 0.156), and overall acceptability (7.60 ± 0.165) and found that orange juice had the excellent overall acceptability certified by the judge. Sensory evaluation is a unique source of product information and involves measuring people's responses to a product in terms of appearance, aroma, taste, texture, and aftertaste, independent of labeling, pricing, or other imagery (Okokon and Otobong, 2019).

Radical scavenging activity (RSA)

DPPH is a stable organic radical with an absorption band around 515-528 nm and is commonly used as a reagent to measure the free radical scavenging activity of antioxidants (Shan *et al*., 2019; Natasa *et al*., 2021). Figure 2 showed that in orange pulp extracted with water and its antioxidant activity was determined by DPPH, which ranges from 9.75 ±

Table I. Quality assessment parameters of Orange pulp

Sr. No.	Para meters	Sample 1	Sample 2	Sample 3	Mean
1	pH	3.70 ± 0.02	3.68 ± 0.03	3.72 ± 0.01	3.70 ± 0.02
2	Brix	64.50 ± 2.30	64.40± 2.28	64.60± 2.32	64.50 ± 2.30
3	Acidity (%)	5.10 ± 0.15	5.23 ± 0.13	5.05 ± 0.11	5.12 ± 0.13
4	Ratio (Brix/acid)	12.64± 0.94	12.31± 0.90	12.79± 0.86	12.58 ± 0.9
5	Pulp (%)	9.64 ± 0.73	9.71 ± 0.70	9.76 ± 0.67	9.70 ± 0.70
6	SO_2	ND	ND	ND	ND

Data are represented ± Standard deviation

Table. II. Organoleptic evaluation of orange pulp (Juice)

No. of Judges	Appearance	Color	Flavor	Taste	Overall acceptability
1	7.20 ± 0.152	6.90 ± 0.140	7.90 ± 0.181	7.30 ± 0.140	7.37 ± 0.210
2	6.80 ± 0.143	7.10 ± 0.175	7.50 ± 0.171	7.20 ± 0.162	7.26 ± 0.202
3	7.00 ± 0.125	7.50 ± 0.168	6.40 ± 0.201	6.60 ± 0.174	8.10 ±0.182
4	6.90 ± 0.120	6.50 ± 0.183	7.90 ± 0.178	7.00 ± 0.192	7.22 ± 0.212
5	7.30 ± 0.142	7.20 ± 0.168	7.45 ± 0.221	6.30 ± 0.156	6.98 ± 0.183
6	6.80 ± 0.152	6.70 ± 0.161	8.10 ± 0.191	7.50 ± 0.168	7.43 ± 0.176
7	7.10 ± 0.135	7.00 ± 0.165	7.80 ± 0.180	6.80 ± 0.148	8. 20 ± 0.165
8	6.85 ± 0.150	8.75 ± 0.150	7.50 ± 0.265	7.20 ± 0.142	7.58 ± 0.187
9	7.35 ± 0.163	7.15 ± 0.178	7.30 ± 0.152	6.75 ± 0.185	8.06 ± 0.220
10	7.40 ± 0.150	7.95 ± 0.188	7.50 ± 0.208	7.10 ± 0.146	7.52± 0.245
Mean Score	7.07 ± 0.146	7.27 ± 0.163	7.52 ± 0.172	6.87 ± 0.156	7.60 ± 0.165

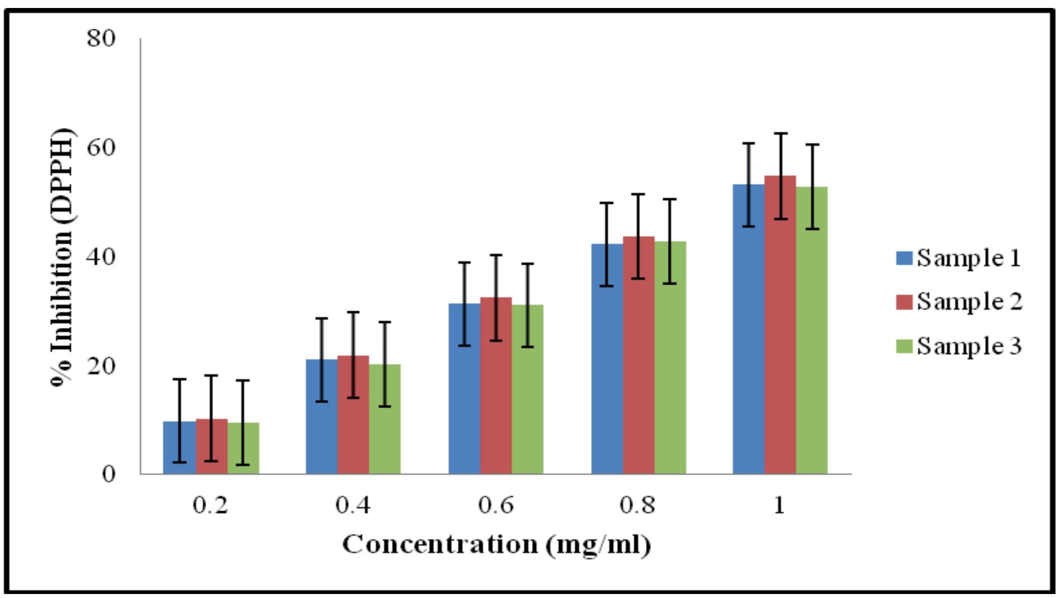

Fig. 2. Radical scavenging activity (RSA) of orange pulp samples

0.45 - 58.76 ± 0.76 % at concentrations (0.2-1.0 mg/ml). The orange pulp water extract showed the highest antioxidant activity (% DPPH scavenging activity), possibly due to the high yield of phenolic compounds (Hegazy and Ibrahium, 2012; Djenidi *et al*., 2020). It is also suggested that these non-phenolic substances can also contribute to the antioxidant activity of the various samples (Oliveira *et al*., 2012). Synergistic effects and other constituents, such as vitamin C, carotenoids, and pigments, can also contribute to orange pulp extract's DPPH free radical scavenging activity (Babbar *et al*., 2011). Our findings are also identical to those described by Arora and Kaur (2013) and Park *et al*., 2014.

Conclusion

The study showed that orange pulp had suitable quality parameters with good overall acceptability without any preservatives. The antioxidant activity of the water extract of orange pulp might be due to the presence of polyphenols, flavonoids and other antioxidant compounds in the pulp extract.

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