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Chemical characteristics of instant powder drink prepared from sour oranges peel *(Citrus aurantium L)*

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Abstract: The peels of sour oranges were processed for the preparation of readily reconstitutable instant powder drink having refreshing taste and natural flavor. Initially the nutrient contents of fresh peels were evaluated chemically and by keeping in view its macro and micronutrients an economically feasible process has been developed by using peels of sour oranges and food grade ingredients as sugar, glucose, citric acid and sodium chloride in known quantity. The peels and the product prepared were evaluated chemically for moisture, ash, fat, crude fiber, sugars (total, reducing, non-reducing), pectin, lignin, vitamin C and some minerals. The overall results showed that the product is a good source of valuable macro and micronutrients, which will contributes to the improvement of quality and choice of food offered to consumers that are beneficial to health.

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INTRODUCTION

Citrus fruits constitute an important group of fruit crops produced all over the world. Pakistan is a major producer of citrus fruits. Citrus fruits are utilized mostly for table purposes, but a significant portion is processed into various products, such as squashes, cordials, single strength juices, juice concentrates, marmalades, pickles *etc*. Citrus is a prized fruit of Pakistan and holds number one position among all fruits both for area and production in the country. Pakistan is among the top 15 citrus producing countries of the world[1]. Yearly world production of citrus fruits has been put at 106 million metric tons and orange fruits represent 65 %[2]. The sour orange *(Citrus aurantium,* L.) is known as bitter orange in Pakistan, *khatta.* The normal types of sour orange are usually too sour to be enjoyed out-of-hand. The greatest use of sour oranges as food is in the form of marmalade. In our country the peels are generally used as animal feed and also as dried small pieces, which are then used in cooked rice (pullaow) for flavoring.

During the processing of citrus fruit for juice, peels are the primary byproduct. If not processed, the peels become waste and a possible source of environmental pollution. In fact, phytochemicals that contribute to health (e.g., flavonoids, carotenoids and pectin) are abundant in citrus peels. The highest amount of flavonoids (a major group of citrus secondary metabolites) occurs in the peel. Neoeriocitrin, naringin and neohesperidin are the main flavanones in the peels of sour orange (C. aurantium), lemon (C. limon) and bergamote (C. bergamia Fantastico)[3,4].

Pectin is a class of complex polysaccharides that function as a hydrating agent and cementing material for the cellulosic network. Commercial pectin is mostly derived from citrus (lime, grapefruit, and orange) and apple[5,6]. Flavonoids have a wide range of biological effects, such as inhibition of key enzymes in mitochondrial respiration, protection against coronary heart disease and anti-inflammatory, antitumor, and antimicrobial activities[7].

Fruit processing industries produce a large amount of waste material in the form of peel, pulp, seeds, etc. Some fresh orange peel is, however, used in shredded form in the preparation of orange-marmalade. This waste material presents considerable disposal problems and ultimately leads to pollution. Dried citrus peel is rich in carbohydrates, proteins and pectin; the fat content, however, is low [8,9]. Citrus fruits contain between 35 % and 55 % juices with extraction of the juice, the remainders of the fruit i.e. peel, membrane, juice vesicles and seeds are discarded as wastes[10].

Traditionally, the waste has been disposed of by dumping or by selling it as fodder. Dumping obviously creates an environmental hazard, whereas marketing of the waste as fodder requires that the waste be dried, which is a costly process. Citrus processors therefore consider other options for utilizing the waste most cost effectively[11].

The large scale manufacturing of juices and concentrates create wastes, as well as wastes of valuable nutrients into the environment. It is necessary to utilize the remaining portions of the sour orange (peel) as byproduct especially in food product. It is therefore, necessary to explore ways and means for sour orange waste utilization by converting it into value added food product. Keeping in view the nutritive value of sour oranges peels and importance of the problems associated with the disposal of food processing industry waste, the present study was undertaken with the objectives of utilizing sour oranges peel for the production of nutritive powder drink.

MATERIALS AND METHODS

The present study was undertaken to evaluate chemical characteristics of instant powder drink prepared from the peels of sour oranges in order to highlight their nutritional significance.

Preparation of sour oranges peel powder drink

The fresh Sour orange peels were obtained from the food pilot plant of PCSIR Laboratories Complex, Peshawar. Graded pieces of sour orange peels were washed with tap water to remove dust and foreign matter. The washed peels minced by meat mincer. The minced material was soaked with sodium chloride to remove the bitterness of the peels. The mixture was blended with water continuously and filtered through muslin cloth. The filtrate obtained was mixed with known amount of food grade additives as sugar, glucose, citric acid and sodium chloride. The final product obtained in a form of powder was packed in polyethylene bags, sealed and kept in refrigerator till further analyses.

Flow sheet diagram of the product

Sour orange peels
↓
Grading
↓
Washing
↓
Mincing
↓
Soaking with NaCl
↓
Blending
↓
Filtration
↓
Filtrate
↓
Mixing
(With additives)
↓
Product
↓
Packing & sealing

Chemical analyses

All chemicals and reagents were of analytical grades (Merk, Germany). Deionized and double distilled water was used for preparing solutions and dilutions. Standard solutions, prepared for the study of elements, were stored in polyethylene containers. Chemical analysis i.e. moisture, ash, fat, crude fiber, sugars (total, reducing, non reducing), lignin and vitamin C was performed using standard methods 925.09, 923.03, 920.85, 920.86, 920.183, 973.18 and 967.21 respectively of AOAC[12]. Triplicate determinations were performed for all parameters and standard deviation was calculated[13].

Analysis of pectin content

A mixture of 5 g of sample powder and 30 ml of hot absolute ethanol was heated in a centrifuge tube for 10 min in a boiling water bath and centrifuged at 10,000 rpm for 10 min at 4 °C. The residues were dried for 24 h at 35 °C, and alcohol insoluble solids (AIS) were obtained. One ml of water was added, drop wise with stirring, for 35 min to a mixture of 5 mg of AIS and 2 ml of concentrated sulfuric acid, in a test tube until the AIS were dissolved. The mixture was transferred into a 25 ml volumetric flask and made up to volume with distilled water for total pectin examination. A mixture of 80 mg of AIS and 20 ml of distilled water was stirred in a centrifuge tube for 5 min at room temperature and centrifuged at 10,000 rpm for 10 min at 4 °C. The residues were extracted twice with 2 x 20 ml of distilled water. All the supernatants were transferred into a 100 ml volumetric flask and made up to volume with distilled water for water soluble pectin examination. In an ice bath, 1 ml of the above sample solution was added to 6 ml of 0.0125 M sodium tetraborate (in concentrated sulfuric acid) and then heated for 5 min in a boiling water bath. Color development followed addition of 0.1 ml of 0.15 % m-hydroxydiphenyl and incubation for 20 min at room temperature. NaOH (0.1 ml) was added instead of 0.15% m-hydroxydiphenyl to the control. Both total pectin and water soluble contents were expressed as galacturonic acid equivalents[14].

Estimation of micro and macrominerals

For minerals estimation, nitric acid-perchloric acid digestion was performed. Briefly the sour oranges peels and the product (1.0 g) were digested with (20 ml) of concentrated nitric acid and then (10 ml) of concentrated perchloric acid. Then the contents were evaporated until the volume was reduced to about 1-2 ml, not to dryness. After cooling, diluted and filtered through pretreated Whatman No.1 filter papers. Filtrate and washing were collected in 100 ml volumetric flasks and made up to the mark with distilled water[15].

Table 1: The instrumental conditions maintained for each element for atomic absorption spectrophotometer model hitachi polarized Z 8000 Japan.

Elements	Wavelength (nm)	Slit width (nm)	Lamp current (mA)	Air flow rate (l/min)	Acetylene flow rate (l/min)	Burner height (mm)
Na	589.0	0.4	10.0	9.5	2.2	7.5
K	766.5	2.6	10.0	9.5	2.3	7.5
Ca	422.7	0.4	7.5	9.5	2.5	10.0
Mg	285.8	2.6	7.5	9.5	2.0	7.5
Co	250.0	0.2	10.0	9.4	2.0	10.0
Cu	324.8	1.3	7.5	9.4	2.0	7.5
Ni	232.0	0.2	10.0	9.4	2.0	10.0
Zn	323.8	1.3	10.0	9.4	2.0	7.5
Fe	248.3	0.2	10.0	9.4	2.3	7.5

nm: nanometer, mA: milli ampere

Instrumentation

The samples were analyzed for micro minerals (Co, Cu, Fe, Ni, Zn) and macro minerals (K, Na, Ca, Mg) by Atomic Absorption Spectrophotometer Hitachi, Model Z-8000, Japan equipped with standard hollow cathode lamps as radiation source using air acetylene flame. The instrument setting and operations were done in accordance with the manufacturer user's specification[15]. Instrumental conditions for the instrument are shown in Table 1. The sample solutions were appropriately diluted, if required, prior to direct measurements and calibration curves were obtained for micro and macro minerals using standard solutions. They were linear and correlation coefficient of each curve was above 0.9900, which indicated a best fit between concentration of the standard solutions and respective absorbance values. Accuracy, precision of the method was verified by standard addition/recovery method[16]. Analysis of each element was carried out in triplicate and standard deviation was calculated[13]. For background correction, blank was analyzed under instrumental conditions. The concentration of minerals was recorded in ppm, converted into mg/g and calculated as mg/100g (on dry weight basis).

RESULTS AND DISCUSSION

The study was undertaken to evaluate the chemical characteristics of the peels (sour oranges) and on the basis of its nutrient contents the instant powder drink was prepared by utilizing these peels. In chemical composition i.e. moisture, ash, crude fat, crude fiber, sugars (total, reducing, non-reducing), pectin and lignin were reported as percent (%), while the vitamin C as mg/100g (Table 2). The minerals were further classified according to their physiological and dietary importance into micro (Cu, Co, Fe, Ni, Zn) and macro (K, Na, Ca, Mg) minerals. In case of minerals, the concentration of these has been shown as mg/100g on dry weight basis (Table 3). The mean and standard deviation were also determined.

It was observed that the sour oranges peels contain moisture content (12.5±0.5%), ash (3.5±0.1 %), fat (1.7±0.2 %), crude fiber (17.2±0.2 %), total sugars (14±1.3%), reducing sugars (10±1.0 %), non reducing sugars (3.8±0.4%), pectin (7.0±0.3%), lignin (5.4±0.3%) and ascorbic acid (84± 2.5 mg/100g).

About 90 percent of vitamin C found in the human diet comes from fruits and vegetables. Citrus fruits are well known to be rich in vitamin C[17]. Vitamin C is also a highly effective antioxidant by protecting indispensable molecules in the body, such as proteins, lipids (fats), carbohydrates, and nucleic acids (DNA and RNA) from damage by free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants (e.g. smoking). Vitamin C may also be able to regenerate other antioxidants such as vitamin E[18].

In peels, among the micro minerals the concentration of Zn (54.7±1.5 mg/ 100g) was maximum; while Fe (36.6±1.1 mg/ 100g) and Ni (10.2±0.2 mg/ 100g) were in moderate amount, whereas Co (4.00±0.3 mg/100g) and Cu (3.00±0.2 mg/100g) were the lowest. In macro minerals, the amount of K (200±2.0 mg/ 100g) was higher than Na (176±2.0 mg/ 100g) and Ca (40.0±1.0 mg/100g), while Mg (26.0±1.2 mg/100g) was the lowest.

There are some micronutrients, which are essential for human health and occur in the body in microgram range. Elements like iron, zinc, copper, manganese, chromium, cobalt and selenium play an important role in the health of individuals, infect their role is as important as that of vitamins. They function as cofactors for many enzymes. It is essential to maintain the required level of trace elements in the human body[19].

On the basis of observed nutrients in peels the instant powder drink prepared showed good concentration of valuable nutrients. The prepared product contains the moisture content (4.0 ± 0.30 %), ash (0.45 ± 0.04 %), fat (0.4 ± 0.02 %), crude fiber (3.5 ± 0.10 %), total sugars (75 ± 3.0 %), reducing sugars (1.6 ± 0.2 %), non-reducing sugars (69.7 ± 2.4), pectin (1.5 ± 0.15 %), lignin (2.2 ± 0.1 %) and vitamin C (20 ± 1.8 mg/ 100g).

In the product, on the basis of micro minerals the concentration of Zn (17.4 ± 0.3 mg/ 100 g) was maximum; Fe (9.10 ± 0.2 mg/100g) showed higher amount then Ni (3.50±0.1 mg/ 100g) and Co (1.20±0.02 mg/ 100g) which were on moderate level, while Cu (1.10±0.01 mg/ 100g) was the lowest. In the macro minerals, the amount of K (52.0 ±1.1mg/100g) was maximum; Na (43.0±1.0 mg/100g) showed higher amount then Ca (10.8±0.3 mg/100g), which was on moderate level, while Mg (8.0±0.1 mg/100g) was the lowest.

Table 2:-Chemical composition of sour oranges peel and powder drink

No	Parameters	Sour orange peels	Sour oranges peel powder drink
1	Moisture (%)	12.5*±0.5**	4.0±0.30
2	Ash (%)	3.5±0.1	0.45±0.04
3	Fat (%)	1.7±0.2	0.4±0.02
4	Crude fiber (%)	17.2±0.2	3.5±0.10
5	Total sugar (%)	14±1.3	75±3.0
6	Reducing sugar (%)	10±1.0	1.6±0.2
7	Non reducing Sugar (%)	3.8±0.4	69.7±2.4
8	Pectin (%)	7.0±0.3	1.5±0.15
9	Lignin (%)	5.4±0.3	2.2±0.1
10	Vitamin C (mg/100g)	84±2.5	20±1.8

* Average of triplicate determination
** Standard deviation values

Sodium and potassium are the major ions in the body fluids. The regulation of proper concentration of these ions in the extra cellular and intra cellular fluid is critical for homeostasis[20]. Magnesium is important to carbohydrate metabolism. It may influence the release and activity of insulin, the hormone that helps control blood glucose levels[21]. Diets that provide plenty of fruits and vegetables, which are good sources of potassium and magnesium, are consistently associated with lower blood pressure[22]. Calcium is essential for the clotting of blood, the action of certain enzymes and the control of the passage of fluids through the cell walls[23].

It is claimed that regular intake of protective minerals in correct proportions in an important measure in the maintenance of health and prevention of disease. Minerals in biological sources are more efficient than pure elemental status, because of presence of elements as well as presence of vitamins and other physiological active compounds[24].

CONCLUSION

It is concluded from the study/result that the sour oranges (*Citrus aurantium* L) peel powder drink is good nutritional product, which will contribute to the improvement of quality and choice of food offered to consumers that are beneficial to health. Sour oranges peel powder is a source of valuable nutrients including fiber, fat, pectin, sugars, lignin, vitamin C and some micro/macro minerals. As peels (citrus wastes) contributes nutrients and are cheaper source of nutrition, available in their respective season at reasonable price which a common man can also purchase and benefit from it with ease. These can be utilized in the formulation of various food products also. So the commercialization of product prepared from sour oranges peel would be a great achievement as an additional diet source.

Table 3: Minerals composition of sour oranges peel and powder drink as (mg/100 gm)

Sample	Microminerals					Macrominerals			
	Co	Cu	Fe	Ni	Zn	K	Na	Ca	Mg
Sour oranges peel	4.00* ±0.3**	3.00 ±0.2	36.6 ±1.1	10.2 ±0.2	54.7 ±1.5	200 ±2.0	176 ±2.0	40.0 ±1.0	26.0 ±1.2
Sour oranges peel powder drink	1.20 ±0.02	1.10 ±0.01	9.10 ±0.2	3.50 ±0.1	17.4 ±0.3	52.0 ±1.1	43.0 ±1.0	10.8±0.3	8.0 ±0.1

* Average of triplicate determination
** Standard deviation values

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