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Determination of Sugar and Mineral Contents in some Omani Fruits

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حساب كمية السكر والمعادن في الفواكه العمانية

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خلاصـة: تـم تحليل مجموعة من الفواكه العمانية لمعرفة كميات السكر والمعادن بها. المعادن التي تمت دراستها هي الكالسيوم، المغنيسيوم، الصوديوم، البوتاسيوم والفسفور. لقد وجد أن كميات السكر والسكر المختزل مشابهة للكميات التي نشرت مسبقاً والتي تمـت دراستها في أماكن أخرى. أما كميات المعادن فقد أظهرت إختلافاً واضحاً عن تلك التي نشرت مسبقاً. لذلك فإنه يمكن تعليل هذا الإختلاف في تركيز المعادن لتركيب التربة والطقس وأنواع السلالات المستخدمة.

ABSTRACT: Omani fruits were analyzed for their reducing sugar, total sugar contents and some minerals. Among the minerals studied were Ca, Mg, Na, K and P. The amounts of total sugar and reducing sugar were within the range of values reported in the literature for the analysis of fruits conducted elsewhere. The amounts of the minerals differ from the reported literature values. This may be attributed to soil composition, climate and type of cultivar.

KEYWORDS: Omani Fruits, Mineral Sugar.

1. Introduction

Fruits and vegetables are important in the Omani diet. Per capita fruit and vegetable consumption in Oman has increased since the 1970's as a result of the remarkable economic and social development that accelerated income growth and caused a substantial change in the diet of the population. The consumption of fruits in 1995 reached more than 90 kg per capita (Omezzine, *et al* 1998). This change is brought about by the increase in consumer awareness towards low fat, high mineral vitamin sources of food; fruits and vegetable are usually low in calories and fat and have no cholesterol making them healthy additions to our diets. Most fruits and vegetables are an excellent source of fiber, vitamins and minerals.

Fruits like all living things contain a wide range of different chemical compounds. An individual fruit is largely composed of living tissues, which are metabolically active and constantly changing in composition. The rate of the extent of such changes depends on the physiological role and the stage of maturity of the fruit concerned. These changes are well documented in the literature. Ting and Vines (1966) reported an increase in citric acid and malic acid with an increase in maturity of citrus fruits. The level of sugar and total acids in cherries was found to increase as they approach maturity. A good correlation was found between color and soluble solids development. These two indices were found to be the best indicators of maturity for good fresh market and canning quality of cherries (Drake, *et al* 1982; Marshall 1954).

The level of sugar content in fruits was reported to be lower in trees with heavy crop as compared to trees with a light crop under similar growing conditions (Mattus, 1966). Furthermore sugar content was reported to be higher in apple fruits grown in areas of reduced moisture availability, high temperature and high sunlight (Mattus, 1966). Cultivar and storage were found to significally influence the content of most sugars in apple juices (Fuleki, 1989).

The ash content represents the total amount of mineral matter in fruit material. The most abundant individual mineral element in fruit is potassium, the content of which is usually between 60 and 600mg/100g of fresh material. The potassium in fruit tissues occurs mainly in combination with the various organic acids in the cell sap. There is little doubt that the pH of the tissue in fruit is controlled by the potassium/organic acid balance. Calcium is mainly associated with the pectic materials of the cell wall. Magnesium is especially abundant in chloroplasts as a constituent of the chlorophyll molecule.

Studies of natural chemical constituents of fruits have important fundamental and applied uses. Knowledge of composition is essential in objectively defining and evaluating the quality of fruit and fruit products, as they proceed through the channels of commerce. Compositional studies provide information about the effects of climate, cultural practices, rootstocks and other biological parameters on the properties of fruits. The degree to which mineral content can vary within a plant species is illustrated by citrus fruits. For citrus fruits grown in Florida, California, Mexico and Brazil, potassium concentrations range from 1520 to 3027mg/L and phosphorous concentration from 124 to 309mg/L were reported (McHard, *et al* 1980).

The ultimate composition of the edible parts of plants is influenced by fertility of the soil, genetics of the plants and the environment in which the plant is grown. In this work the nutrient composition of Oman fruits is determined. The contents investigated are sugar and minerals. The fruit samples studied were those usually used in the average household in Oman for normal consumption. No attempt was made to obtain fruits grown from various regions of the Sultanate. Hence factors such as pre or post harvest, choice of cultivars, cultural practice, storage conditions and growing location were not taken into consideration, although such factors are known to play a major role in nutrients content of fruits (Batten 1994, Cookson 1996, Fawzi *et al* 1996, El-Fouly and Shaaban 1999, Shaaban and El-Nour 1996). However, these aspects will be investigated in future studies since it is important to decide the localities in which improvements are required.

2. Experimental

2.1 Materials

Fruits locally grown were collected from the Public Authority for agriculture products in Ghala. These were: Quince (*Cydonia oblongo*), Sour Orange (*Citrus aurantium*), Lime (*Citrus aurantifolia*), Grape fruit (*Citrus paradisi*), Sweet Orange (*Citrus sinensis*), Pomelo (*Citrus grandisi*), Coconut (*Cocoa Nucifera L*), Pomegranate (*Punica granatum*), Banana (*Musa acuminata*), Melon (*Cucumis melo*), Nabag (*Ziziphus Mauritania, Ziziphus Namulania, Ziziphus Spina Christi*), Guava (*Psidium guavaya*) and Papaya (*Carica papaya*). All chemicals used were of Analar grade and were obtained from BDH chemicals Ltd, Poole, England. Ammonium molybdate was purchased from Gaindland chemical company, Sandycroft, Deeside, U.K.

2.2 Method

2.2.1 Juice Sample Preparation

Fresh juice was squeezed from the fresh fruit. Sufficient filter aid was added to form a thin paste. The paste was then filtered using a Buchner funnel to obtain the clear fruit juice.

2.2.2 Whole Fruit Sample

Fresh fruit samples were weighed, blended with a small amount of distilled water and filtered. The filtrate was quantitatively transferred into a 250-ml volumetric flask.

2.2.3 Preparation of Ash Sample

Concentrated juice sample (50.00 ml) was placed on steam bath to remove all the water, then put in a muffle furnace at 550^{o}C for 10 to12 hours until the ash became whitish in appearance. 6M

HCl (2ml) was added to dissolve the ash sample. The sample was then transferred quantitatively to a 50 ml volumetric flask.

2.2.4 Determination of total and reducing sugars

This was carried out according to the method of Lane-Eyron (Ting and Rouseff 1986).

2.2.5 Determination of mineral elements

Mineral contents were determined from the ash samples solution. All the samples were duplicated and analyzed five times. Analytical results with coefficient of variation (CV) more than 10 % were rejected.

Calcium and magnesium were determined by the atomic absorption spectrophotometry model AL-PHA 4 UK. Absorbance of the sample was read at 422.7 nm for Ca and 258.2 nm for Mg. The ash sample prepared as described above was diluted ten fold with deionized water.

The determination of sodium and potassium was achieved by flame photometry. (Flame Photometer Gallenkamp, model FGA-350-L UK). The ash sample solution was diluted a hundred fold for K; the original ash solution without dilution was used for Na determination.

The determination of Phosphorous was by the colorimetric method using ammonium molybdate HCl – solution. (Ting and Rouseff 1986). Absorbance reading of the complex was read at 650 nm using spectrophotometer PU 8620 (Phillips). The ash solution was diluted fifty fold.

3. Results and Discussion

The highest amount of total sugar content in fruit juice was found in quince and the lowest in sour oranges (see Table1). 70% of total sugar found in quince was in the form of reducing sugar. The highest percentage of reducing sugar content was found in sour orange while the minimum in sweet orange (Table 1). The total sugar found in Omani oranges agreed well with the previously reported values (Eskin, 1991) for Florida orange. Among the whole fruits studied, banana has the highest total sugar content and guava the minimum (Table 2). Pomegranate exhibited the highest percentage of reducing sugar. Fleshy fruits such as melon, *ziziphus Mauritania*, guava and papaya have reducing sugar in the range of 53-56% (Table 2). The results for the total sugar content reported here for banana, *ziziphus Mauritania*, *zizphus Nammulania* and *ziziphus Spina christi* are in agreement with the previously reported literature values (Khan, *et al* 1979).

Table 1: Amount of reducing sugar and total sugar in fruit juices g/100ml.

Fruits	Reducing Sugar	Sucrose	Total sugar	True total sugar	% of reducing sugar	% of sucrose	CV %
Quince	8.56	3.63	12.38	12.19	70.2	29.8	0.40
Sour orange	3.32	0.63	3.98	3.95	84.1	15.9	0.35
Lime	3.19	1.57	4.84	4.76	67.0	33.0	0.42
Grapefruit	3.55	2.54	6.22	6.09	58.3	41.7	0.55
Orange	4.74	3.48	8.40	8.22	57.7	42.3	0.32
Pomelo	5.81	3.13	9.10	8.94	65.0	35.0	0.61
Coconut	5.12	1.10	6.28	6.22	82.3	17.7	0.52

Sugar types and concentrations in fruits affect their taste. Most fruits undergo changes in their sugar content during maturity. Hence the monitoring of sugar contents and their respective ratio may indicate the level of maturity as well as physiological status during storage. Marshall (1954) reported a 200 % increase in sugar contents of cherries during maturity. Similar findings were reported for apples and pears (Mattus, 1966). Sugars comprise the most abundant soluble carbohydrates in citrus fruits with the exception of acidic citrus fruits such as lemon and lime.

During maturation the sugar in the juices of all citrus fruits increases both in concentration and in absolute amounts. In mature oranges, total-reducing sugar is approximately equal to sucrose (Ting and Rouseff 1986) while in other citrus fruits the amount of sucrose is less. Mature tangerines have been reported to contain a higher sucrose content compared to fructose and glucose (Ting and Rouseff 1986). The ratios of sugar to sucrose of Oman citrus fruits studied here were substantiate the findings of Fuleki (1989) who reported that growing areas did not have a significant effect on similar to the values reported by Ting and Attaway, (1971) for mature citrus fruits. These results sugar composition of apples. All the values of sugar reported have an error of less than 1.0% with CV ranging from 0.4% for pomegranate to 0.6% for quince (n=10).

Table 2: Amount of reducing sugar and total sugar for the whole fruit sample g /100g.

Fruits	Reducing Sugar	Total sugar	Sucrose	True total sugar	% of reducing sugar	% of sucrose	CV %
Pomegranate	8.58	11.38	2.66	11.24	76.3	23.7	0.40
Banana	12.95	19.53	6.25	19.20	67.4	32.6	0.45
Melon	7.33	14.21	6.54	13.87	52.8	47.2	0.52
Ziziphus (Mauritania)	4.69	8.98	4.07	8.76	53.5	46.5	0.61
Ziziphus Namulania)	9.45	12.62	3.01	12.46	75.8	24.2	0.58
Ziziphus (Spina Christi)	11.48	17.39	5.61	17.09	67.2	32.8	0.32
Guava	2.87	5.26	2.27	5.14	55.8	44.2	0.38
Papaya	4.93	9.24	4.09	9.02	54.7	45.3	0.53

Table 3: The amount of mineral elements in fruit juice mg/100 ml.

Fruit	K	Na	Ca	Mg	P
Quince	42.6	13.3	24.3	40.5	8.0
Sour Orange	102.1	17.2	6.25	52.0	6.0
Orange	46.3	17.8	5.92	25.0	16.0
Grape fruit	7.4	8.0	29.0	25.6	22.0
Pomelo	45.7	13.3	16.5	28.9	12.0

The amount of potassium in the Omani fruit range from 7.4-mg/100 ml for grapefruit juice to 102.1mg/100 ml for sour orange juice (Table 3). For whole fruit the concentration of potassium varies from 1.3 mg/100g for *ziziphus Mauritania* to 20.2 mg/100 for pomegranate (Table 4). The value of potassium for orange juice reported here was much lower than the values reported before for Florida and Brazil oranges (McHard, *et al* 1979). The amounts of potassium obtained from *Ziziphus* was compared with the previously reported values, (Khan, *et al* 1979). Sour orange is a good source of potassium. Individuals with concerns of hypertension are advised to reduce their sodium intake and consume foods high in potassium in order to achieve an improved sodium/potassium ratio.

Concentration of calcium ranges from 4.5 mg/100g for pomegranate to 20.5 mg/100g for muskmelon. No calcium was detected by our instruments for the ziziphus family and for guava (Table 4). The minimum amount of calcium was found in orange and the maximum in grapefruit juice.(Table 3). Calcium and potassium are essential plant nutrients; and their concentrations in the juice and in the edible portion of the fruit depends upon the genetic make up, as well as the soil characteristics. These elements are essential for human nutrition. Their deficiencies, rather than toxicity, are of human health concerns.

The amount of magnesium(Mg) in fruit juice ranges from 25.0mg/ 100ml in sweet orange to 52.0mg/100ml in sour oranges. Among the edible flesh fruits papaya contained the maximum concentration of the element (36.7 mg/100g) and *ziziphus Numulania* the minimum (2.6 mg/100g). Magnesium is an essential element for human, animal and plant nutrition.

Table 4: The amount of mineral element in whole fruit mg/g.

Fruits	K	Na	Ca	Mg	P
Pomegranate	20.2	0.75	4.5	28.7	6.0
Banana	10.3	0.62	7.0	14.8	32.5
Musk Melon	4.3	0.03	20.5	23.9	7.5
Papaya	14.1	0.84	6.4	36.7	9.5
Ziziphus (Mauritania)	1.3	0.03	-	2.64	3.2
Ziziphus (Numulania)	1.6	0.70	-	2.58	3.7
Ziziphus (Spina Christi)	2.3	0.55	-	2.85	1.3
Guava	2.5	0.09	-	2.94	0.7

Sodium concentration in fruit juice is given in Table 3. The values obtained in citrus fruit are higher than previously reported in the literature (McHard, *et al* 1979). Again it reflects fruit characteristics which depend on type of soil and nutritional practices. There was no significant difference in the value obtained in the *ziziphus* locally grown and the literature values (Khan, *et al* 1979). Foods contribute more to the daily intake of sodium than drinking water (NRC 1977). An impressive amount of evidence has been accumulated over the last several decades, which suggests that sodium taken in excess of physiological needs induce an age–related blood pressure and hypertension.

Among the fresh fruit juices studied, sour orange contained the smallest amount of phosphorous (P) (6mg/100ml) and grapefruit the largest (22 mg/100g). Guava contained only trace amount of P while banana had the maximum concentration (32.5mg/100g). Phosphorous is essential for bone and teeth mineralization for energy use in ATP, phospholipids and acid-base balance.

Compositional studies of the fruits is important in understanding the biosynthetic and regulatory systems of fruits, which in turn determine and control the chemical composition of the fruit. Considerable data are available in the literature on the composition of fruits. Yet the variability of each constituent may be so great that the data cannot be used for strict control of juice composition or for food processing. The mean values of some constituents also vary according to the geographical location. It is imperative that a data base on the composition of authentic juice be obtained from each fruit growing country using similar approved methods. Data should be collected for more than a single season to study the effect of weather. Furthermore, the compositional study using similar approved methods should be concurrent with the type of soil, fertilization and cultural practice. Most commercial farmers use fertilizers to increase crop products. These fertilizers contain plant nutrients, which replenish the soil with the required nutrients. However, it is important to study the composition of the soil so as to evaluate the nutrient status of the soil and to investigate the bio-availability of both micro and macro elements. Previous studies (El-Fouly and Shaaban, 1999) indicated a nutrient disturbance in the horticultural crops examined in Salalah region in the Sultanate of Oman. This will affect the composition of fruits grown in this region. The ratio of major sugar in fruits is a characteristic feature of the fruit and serves as a fingerprint for fruit quality provided the fruits are grown using the same type of soil, cultivar and nutritional practice.

4. Conclusion

The amounts of sugar in Omani fruits studied here were found to be within the range reported previously for the same fruits grown elsewhere in the world. However, levels of minerals were found to be different. For example, when compared to Florida oranges, Omani oranges showed lower levels of K and P and higher levels of Na.

The effect of choice of cultivars, fertilization practice and soil of different levels of nutrient on fruit composition although important was not carried out. This is intended to form the next study in our project to quantify the properties of Oman fruits.

References

BATTEN, G. D. 1994 Concentration of elements in wheat grain grown in Australia, North America and the United Kingdom. *Aust.J.Exp.Agrc*-**34:** 51-56.

COOKSON, P. 1996. Soil Research in Oman : opportunities and priorities. *SQU J. Scientific Research-Agriculture Sciences*, **1:** 25-32.

DRAKE, S. R., *PROEBSTRING E.L. JR and SPAYD*, S.C. 1982, Maturity index for the color grade of canned dark, sweet cherries. *J.Am.Soc.Hortic.Sci.***107:**180.

EL-FOULY, M.M. and SHAABAN, M.M.. 1999. Status of some horticultural crops in Salalah region, *SQU J. Scientific Res.-Agricultural Sciences* **4(2):** 47-52.

ESKIN, N. A. 1991. *Quality and preservation of fruits*. CRC Press Boca Raton Florida.

FAWZI, A.F.A, SHAABAN, M.M. and ABOU EL-NOUR. Z.A.A.1996. Nutritional status and nutrients removed by the fruits of three-mango cultivar grown under farm Conditions. *J.Agric.Sci*., *Mansoura University*., **12(6):** 2301-2317.

FULEKI, T. 1989. Chemical fingerprinting of fruits. Detection of fraudulent activity in fresh and processed fruits in research projects summary Agriculture and Food Research Fund. *Pers. Comm*.

KHAN, A.A., ASHRAF, M and NASREEN, M.A. 1979. Pharmacognostic studies of selected indigenous plants of Pakistan. Pakistan Forest Institute, Peshawar, pp 85.

MATTUS, G. 1966. Harvest and Postharvest handling of apples, *American Fruit Grower* **86(8)**.

MARSHALL, R.E 1954 *Cherries and cherry Products*. Intersciences, New York. U.S.A.

MCHARD, J .A., FOULK, S.J. and WINEFORDNER, J.D.1979 A comparison of trace elements contents of Florida and Brazil orange juice. *J.Agric. Food Chem*., **27:**1326-1328.

MCHARD, J.A., FOULK, S.J., JORGENSEN, J.L., BAYER, S. and WINEFORDBER, J.D.1980 Analysis of trace metals in orange juice. In Citrus Nutrition and Quality American Chemical Society Symposium Series No 143, Washington, D.C, pp363-392.

NRC 1977 Drinking Water and Heath. National Research Council. National Academy of Sciences, Washington, DC.

OMEZZINE, A., CHOMO, G.V and AL-JABRI, O.1998 Demand Analysis of Selected Fruits and Vegetables *SQU J. Scientific Res.-Agricultural Sciences* **3:** 19-26.

SHAABAN, M.M and ABOU EL-NOUR. Z.A.A.1996 The Nutrient balance in Egyptian clover (*Trifolium alexandrum*) as affected by the yield. *J.Agric.Sci., Mansoura University*., **21(6):** 2293-2299.

TING S. V and ATTAWAY J.A 1971. In the Biochemistry of fruits and their Products Vol 1 (A.C Hulme Gd) Academic Press London and New York, 107-169.

TING, S.V and ROUSEFF, R.L 1986. *Citrus Fruits and their products analysis and technology*. Marcel Dekker, New York.

TING, S.V and VINES, H.M 1966 Organic acids in the juice vesicles of Florida Hamlin oranges and Marsh seedless grapefruit. *Proc.Amer.Soc. Horti.Sci*.**88 :** 291-295.

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