Comparison of the Nutrient Content of Fresh Fruit Juices *vs* Commercial Fruit Juices

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Abstract

Objective : To compare the types and quantities of carbohydrate, electrolytes, pH and osmolarity of fresh fruit juices and commercial fruit juices.

Material and Method : Forty kinds of fresh fruits available in Thai markets were analyzed for types and quantities of carbohydrate, electrolyte, pH and osmolarity and compared with previously obtained data for commercial fruit juices.

Results : Most fresh fruit juices did not contain sucrose, whereas, commercial fruit juices mostly have sucrose in the range of 3-112 g/L. Although both fruit juices were acidic (pH varied from 3.6-6.7 and 3.2-5.8 of fresh juice and commercial juice), fresh fruit juices had a more neutral pH than commercial fruit juices. Apple, guava, orange, pear, and pineapple juices from commercial fruit juices had a high osmolarity compared with fresh fruit juices. All types of fresh fruit juices contained less sodium than commercial ones, whereas, most fresh fruit juices contained more potassium, phosphorus, and magnesium than commercial fluids.

Conclusion : The nutrient content of fresh fruit juices and commercial fruit juices from the same kinds of fruits are not the same, possibly due to the manufacturing process. Therefore, physicians should know the composition of fruit juices in order to advise patients properly.

Key word : Fresh Fruit Juices, Commercial Fruit Juices, Sucrose, Fructose, Glucose, Sorbitol, Osmolarity, pH

DENSUPSOONTORN N, JIRAPINYO P, THAMONSIRI N, et al
J Med Assoc Thai 2002; 85 (Suppl 2): S732-S738

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When the infants and young children are fed with solid foods that have a high renal solute load, it is recommended that they consume large amounts of fruit juice e.g. orange juice and apple juice which are also rich sources of vitamin C which prevents scurvy. Fruit not only contains water, vitamins and fiber but also includes sugar and electrolytes. The four major sugars in fruit juice are sucrose, glucose, fructose and sorbitol. Although all juices contain fructose, some contain sorbitol. Sucrose is hydrolyzed by sucrase that is located in the small intestinal epithelial cells into glucose and fructose. Glucose is absorbed *via* an active transport system. Fructose is absorbed by a facilitated transport process, at a slow rate, which is enhanced by simultaneous ingestion of glucose or galactose(1). The greatest absorption is observed when equal amounts of fructose and glucose are given concomitantly(1,2). Results suggest that paired monosaccharides may be absorbed by the disaccharidase-related transport system because they are the products of the enzymatic hydrolysis of sucrose. Sorbitol, a polyol sugar used as sugar-free sweetener, is slowly absorbed by passive diffusion in the small intestine (approximately 10%)(3). Excessive drinking of fruit juice may cause carbohydrate malabsorption which presents with abdominal pain, bloating, flatulence and eventually chronic diarrhea, which commonly appears with fruit juice containing a higher amount of fructose than glucose or in the presence of sorbitol. In contrast, their specific characteristics can result in benefit for a patient with constipation. Several studies have investigated carbohydrate malabsorption after fruit juice ingestion by measuring breath H_2 gas excretion (4-10). The risk of dental caries should be considered if the infants and young children are given juice from a bottle or the frequency of intake is high. Recently, data concerning the constituents of commercial fruit juices have been studied(11). However, those of fresh fruit have never been studied before. Nowadays, consumption of whole fruit, fresh fruit juices and commercial fruit juices has become popular with Thai people. Their characteristics in terms of electrolytes, osmolarity, pH, types and contents of carbohydrate are different.

The purpose of the present study was to study the differences in the components of fresh fruit juices from those of commercial fruit juices which have been studied previously.

MATERIAL AND METHOD

Study design

An observational descriptive study was performed. Forty kinds of fresh fruit obtainable in Thai markets were analyzed for type and quantities of carbohydrate, electrolytes, pH and osmolarity. One hundred grams of fresh fruit that had been peeled, followed by juice extraction were studied. Each fruit juice was divided into three parts and analyzed three times as follows :

A. Analysis of carbohydrates

Types and amounts of carbohydrate were analyzed using High Performance Liquid Chromatography with the same equipment used in a previous study(11).

B. Analysis of electrolytes

The concentration of sodium, potassium, calcium and magnesium were analyzed using the atomic absorption test, and those of chloride and phosphate were analyzed by a calorimetric method as in the study of Jirapinyo et al(11).

C. Analysis of osmolarity and pH

Osmolarity was determined by Osmomat 030 equipment. pH was measured by a pH meter.

The results of each fruit juice were averaged and the data from commercial fruit juices derived from the previous study(11).

Statistical analysis

Data of both juice groups were expressed as the mean of all subtypes of each fruit juice. The authors determined if the sample size of each fruit in both groups would be insufficient to detect a difference of their components by inferential statistics. Descriptive statistics were generated for all variables of interest.

RESULTS

Comparative data in the tables demonstrate only the type of fresh fruit juices, for which there was a corresponding commercial fruit juice.

Table 1 shows the comparison between types and content of carbohydrate and pH of fresh fruit juices and those of commercial fruit juices from the same fruits. Most fresh fruit juices do not only contain sucrose, whereas, commercial fruit juices

Table 1. Comparison of carbohydrate, and pH of fresh fruit juices *vs* commercial fruit juices from the same fruits.

Type of juice	Total carbohydrate (g/L)		Sucrose (g/L)		Glucose (g/L)		Fructose (g/L)		Sorbitol (g/L)		pH	
	F*	C**	F*	C**	F*	C**	F*	C**	F*	C**	F*	C**
Apple	51	96	12	3	11	31	28	62	-	-	3.8	3.2
Grape	53	96	-	-	18	42	35	54	-	-	3.8	3.2
Guava	21	91	-	11	9	34	12	46	-	-	4.0	3.4
Litchi	68	94	-	5	23	28	45	61	-	-	4.0	3.3
Longan	67	167	-	112	42	38	25	17	-	-	6.7	5.8
Mango	96	78	-	23	53	21	43	34	-	-	4.9	3.7
Orange	45	105	10	47	20	37	15	25	-	-	4.8	3.7
Pear	40	94	-	12	7	30	33	52	16	12	4.2	3.4
Pineapple	75	99	25	32	25	42	25	46	-	-	4.1	3.7
Prune	78	119	-	12	58	53	20	54	34	54	3.6	3.4

F Data from fresh fruit juices
C Data from commercial fruit juices
* Values are shown as the mean of all subtypes of each fruit
** Value are expressed as the mean of all brands of each fruit juice

almost all contain sucrose. Fresh juices of grape, guava, litchi, longan, mango, pear and prune have no sucrose contrary to commercial brands (grape : TIPCO, IVY, UFC, UNIF ; guava : TIPCO, SINGHA, UFC, MALEE, DOICUM ; litchi : PIGEON ; longan : SINGHA ; mango : PIGEON ; pear : IVY ; prune : DELMONTE, SINGHA). Fresh juices of orange and pineapple contain less sucrose than commercial fruit juices (orange : TIPCO, IVY, A-TIP ; pineapple : TIPCO, SINGHA, MALEE). Royal gara and Green apple juices have no sucrose. Fuji, Washington and China apple juices have sucrose in the range of 9-27 g/L. MALEE brand of apple juice contains no sucrose, whereas, TIPCO brand comprises this sugar in the amount of 5 g/L. A commercial brand of longan juice has the highest sucrose content (112 g/L) in spite of the fact that no sucrose is found in fresh longan juice. Most fresh fruit juice contains less glucose and fructose than commercial fruit juice. Consequently, the total carbohydrate content of fresh fruit juices are less than those of commercial juices. Although both fruit juices are acidic, all types of fresh fruit juices have a more neutral pH than commercial fruit juices.

Table 2 shows the comparison of the osmolarity of fresh fruit juices with commercial fruit juices from the same fruits. Commercially prepared apple, guava, orange, pear, and pineapple juices have a higher osmolarity compared with the fresh fruit juices from the same fruits.

Table 3 shows the comparison of the electrolyte contents of fresh fruit juices and commercial fruit juices from the same fruits. All types of fresh fruit juices contain less sodium than commercial juices. In contrast, most fresh fruit juices contain more potassium, phosphorus, and magnesium than commercial ones.

DISCUSSION

Fruit is one of the five-major food groups in the Food Guide Pyramid. Fruit juice is generally consumed as the main source of ascorbic acid and other vitamins. In addition to vitamins, fruit juices are composed of many nutrients including fructose, glucose, sucrose, sorbitol, and electrolytes. Although fruit juice offers no nutritional advantage over whole fruit and also is depleted of fiber, fruit juice has become more popular than whole fruit, especially commercial fruit juice that is manufactured and packaged in several forms such as cans, boxes, or bottles in ready-to-drink form. The components of fresh fruit juice should be similar to those of commercial fruit juice but in fact, they may be different due to the manufacturing process which is geared to produce a good taste.

In the present study, the types of carbohydrate found in fresh fruit juices were fructose, glucose, sucrose, and sorbitol similar to a previous study of commercial fruit juices[11]. All fresh fruit juices contained fructose and glucose in different

Table 2. Comparison of the osmolarities of fresh fruit juices *vs* commercial fruit juices from the same fruits.

Type of juice	Fresh fruit juices (mOsm/kg)	Commercial fruit juices (mOsm/kg)
Apple	741	874 *
Grape	1,156	1,046
Guava	458	839*
Litchi	1,219	793
Longan	1,183	545
Mango	1,246	578
Orange	678	825*
Pear	744	856*
Pineapple	854	858*
Prune	1,544	1,244

* Data showed that the osmolarities of commercial fruit juices were higher than those of fresh fruit juices

Table 3. Comparison of the electrolyte contents of fresh fruit juices *vs* commercial fruit juices from the same fruits.

Type of juice	Na (mg/L)		K (mg/L)		Cl (mg/L)		Ca (mg/L)		P (mg/L)		Mg (mg/L)	
	A	B	A	B	A	B	A	B	A	B	A	B
Apple	17	135*	815	572†	43	75	14	40	42	96	47	35
Grape	47	389*	1,684	211†	219	80	33	47	130	93††	93	31
Guava	16	94*	1,874	494†	394	365	24	20	99	17††	74	15
Litchi	16	199*	972	154†	268	48	17	31	170	68††	240	12
Longan	14	143*	1,503	366†	362	55	12	11	308	26††	156	8
Mango	8	266*	2,106	237†	365	70	54	24	161	10††	28	22
Orange	35	32*	1,788	1,152†	158	337	59	50	178	77††	160	46
Pear	16	73*	498	562	25	75	11	53	37	32††	45	32
Pineapple	16	65*	1,312	1,203†	146	88	41	118	82	58††	295	114
Prune	4	77*	1,242	3,488	362	890	72	165	217	164††	212	218

A Data from fresh fruit juices
B Data of commercial fruit juices
* Higher sodium content compared with fresh fruit juices
† Lower potassium content compared with fresh fruit juices
†† Lower phosphorus content compared with fresh fruit juices

amounts and not all contained sucrose. Few fruit juices had sucrose. As expected, sucrose was found in higher amounts in commercial fruit juices than in fresh fruit juices in spite of using the same kinds of fruits. This might have resulted from extrinsic addition by the manufacturers in order to produce a juice that is sweeter than the original juice as a marketing strategy. Frequent high consumption of hidden sugar in several brands of fruit juices could cause an increased prevalence of dental caries, overnutrition and undernutrition in young children. Fruit intake used to be one of the dietary factors associated with cariogenicity[12]. Dennison et al reported that the consumption of 12 fl oz or more per day of fruit juice by young children was correlated with short stature and obesity[13], contrary to the study by Skinner et al that indicated no statistically significant difference in children's height, body mass index or ponderal index related to fruit juice intake[14]. Breast milk is generally accepted to be the source of nutrients for infants. The American Academy of Pediatrics (AAP) has recommended that breast milk should be the only nutrient provided to infants until 4 to 6 months of age[15]. Inappropriate juice intake

compared with solid food could have a possible detrimental effect on the intake of breast milk or infant formula. Consumption of a large quantity of fruit juice might displace more calorie-and nutrient-dense foods leading to deterioration of growth parameters[16]. Additionally, there is an inverse correlation, with a decreased intake of fat, protein, vitamin D, and micronutrients (Fe and Zn) with an increase in non-milk extrinsic sugar intake[17]. In contrast, overconsumption of hidden sugar in fruit juices could result in an increased calorie intake and development of obesity. The AAP, Committee on Nutrition recommended that juice should not be introduced into the diet of infants before 6 months of age and limited to 4 to 6 fl oz per day for children 1 to 6 years old and 8 to 12 fl oz or 2 servings per day[18]. The AAP recommendations on fruit juice intake also state that parents should not provide infants with fruit juices in bottles or easily transportable cups or boxes, which allow them to drink juice easily throughout the day including at bedtime in order to prevent prolonged exposure of the teeth to a high sugar fluid to control the risk of dental caries. Furthermore, all types of commercial fruit juice are more acidic than fresh fruit juice. This might be the result of higher carbohydrate content. This may produce enamel demineralization. Corresponding to the study by Toumba et al, blackcurrant drink with a lower level of carbohydrate (0.8%) compared with a mixed citrus fruit drink with a higher carbohydrate content (4.5%) had a low acidogenic potential and no depression of the plaque pH below a critical level, which did not cause a risk of enamel demineralization[19].

The present study revealed some fresh fruit juices containing a high fructose-to-glucose ratio such as pear, apple, and grape and a few fruits having sorbitol e.g. prunes, pears and plums. Several studies have found that excessive consumption of fruit juices containing more fructose than glucose and/or sorbitol resulted in incomplete carbohydrate absorption presenting with chronic non-specific diarrhea or toddler's diarrhea[3,6,8,10,20-22]. Breath hydrogen excretion of 20 ppm or more after apple juice, pear juice consumption indicates malabsorption of fruit juice carbohydrate[6,8,22]. Unabsorbed carbohydrate in the small bowel is fermented by fecal flora in the colon and produces hydrogen, carbon dioxide, methane gas and short-chain fatty acids. Some of these gases are reabsorbed, then excreted *via* expired air. The osmotic load that causes diarrhea is attributed to nonabsorbed carbohydrate and short-chain fatty acids. Consequently, clinical symptoms such as flatulence, bloating, abdominal pain and diarrhea can appear. On the other hand, physicians can apply the specific characteristic of fruit juice as a laxative for the management of constipation. A study by Stacewicz-Sapuntzakis et al showed the laxative action of both prunes and prune juice, which is explained by a high sorbitol content (14.7 and 6.1 g / 100 g, respectively)[23].

The osmolarities of some commercial fruit juices were higher than fresh fruit juices from the same fruits, which might result from the high carbohydrate content and the addition of sodium (as salt). The sodium content was found to be relatively higher in all commercial fruit juices than in fresh fruit juices from the same fruits which was contrary to potassium and phosphorus levels. Selecting a fruit juice containing very low levels of sodium or sugar should not pose a problem to hypertensive or diabetic patients, respectively. The high level of potassium and phosphorus in fruit juice could be noxious to patients suffering from chronic renal failure. Thus, physicians should suggest the appropriate fruit juice based on the data provided.

In general, the ORS recommended by the WHO for rehydration of patients with dehydration due to acute diarrhea of any etiology is formulated from glucose (20 g) and sodium (90 mmol) to be mixed in 1 litre of water. In fresh fruit juices, apple juice (Royal gara) and plum juice contained about 2 g/dl of glucose and the sodium content was 0.7 and 0.2 mmol/L, respectively. In common with fresh fruit juices, guava juice (25% MALEE) and Mango (25% PIGEON) also contained about 2 g/dl of glucose and the sodium content was 4.7 and 11.6 mmol/L, respectively. Moreover, white grape juice (TIPCO) had the highest sodium content of all commercial forms (61 mmol/L) and a glucose content of 3.6 g/dl. Thus, the data obtained in this study demonstrates that fresh and commercial fruit juices are not suitable fluids to use as ORS because their contents are inappropriate.

SUMMARY

On comparison, the type and quantities of carbohydrates, electrolytes, osmolarity and pH not

only varied with each type of fruit, but also differed between fresh fruit juices and commercial fruit juices in spite of the fact they were produced from the same kinds of fruits. Physicians should be knowlegeable about the components of each fruit juice to advise patients about consumption.

(Received for publication on March 10, 2002)

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การศึกษาเปรียบเทียบส่วนประกอบของสารอาหารระหว่างน้ำผลไม้สดและน้ำผลไม้บรรจุภัณฑ์

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วัตถุประสงค์ : เพื่อศึกษาเปรียบเทียบชนิดและปริมาณของคาร์โบไฮเดรท เกลือแร่ ค่าพีเอ็ชและออสโมลาริตี้ของน้ำผลไม้สดและน้ำผลไม้บรรจุภัณฑ์

วัสดุและวิธีการ : ผลไม้ 40 ชนิด ที่มีวางจำหน่ายอยู่ทั่วไปในตลาดไทยถูกนำมาวิเคราะห์เกี่ยวกับ ชนิดและปริมาณของคาร์โบไฮเดรท เกลือแร่ ค่าพีเอ็ช และออสโมลาริตี้ เปรียบเทียบกับข้อมูลการศึกษาเดิมของน้ำผลไม้บรรจุภัณฑ์

ผล : น้ำผลไม้สดส่วนใหญ่ไม่มีน้ำตาลซูโครสตรงกันข้ามกับในน้ำผลไม้บรรจุภัณฑ์ที่มีน้ำตาลซูโครสและมีในปริมาณที่มากกว่าประมาณ 3-112 ก./ล. ค่าพีเอ็ชของน้ำผลไม้สดมีค่าตั้งแต่ 3.6-6.7 ซึ่งมีความเป็นกรดน้อยกว่าน้ำผลไม้บรรจุภัณฑ์ที่พีเอ็ชมีค่า 3.2-5.8 น้ำแอปเปิ้ล, น้ำฝรั่ง, น้ำส้ม, น้ำสาลี่, และน้ำสับปะรดของชนิดน้ำผลไม้บรรจุภัณฑ์มีค่าออสโมลาริตี้มากกว่าชนิดน้ำผลไม้สด น้ำผลไม้สดทุกชนิดมีปริมาณโซเดียมน้อยกว่าน้ำผลไม้บรรจุภัณฑ์ ตรงกันข้ามกับปริมาณโปแตสเซียม, ฟอสฟอรัส, และแมกนีเซียมที่พบในน้ำผลไม้สดมากกว่าน้ำผลไม้บรรจุภัณฑ์

สรุป : สารอาหารและส่วนประกอบของน้ำผลไม้มีความแตกต่างกันทั้งในน้ำผลไม้สดและน้ำผลไม้บรรจุภัณฑ์ แม้จะมาจากผลไม้ประเภทเดียวกันอาจมีสาเหตุจากกระบวนการผลิต ดังนั้นแพทย์ควรจะมีความรู้เกี่ยวกับคุณลักษณะของน้ำผลไม้แต่ละชนิดเพื่อเป็นแนวทางในการประยุกต์ใช้ให้เหมาะสมกับสภาวะของผู้ป่วย

คำสำคัญ : น้ำผลไม้สด, น้ำผลไม้บรรจุภัณฑ์, ซูโครส, ฟรุคโตส, กลูโคส, ซอร์บิทอล, ออสโมลาริตี้, พีเอ็ช

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จดหมายเหตุทางแพทย์ ฯ 2545; 85 (ฉบับพิเศษ 2): S732-S738

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