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Comparative Study of Solubility of Urinary Stones in Juices of Different Common Edible Natural (Fruits) Sources

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Renal calculi are in general hard to break and the hardness varies from stone to stone depending on their constituents and size. Risks of renal stone formation are much fold increase in acidic medium rather than in alkaline medium. Foods that are high in citrate content generally are assumed to deliver alkali load and hence reduce the risk of stone formation. The object of this study is to compare the solubility properties of renal calculi of different forms and size (whole and powdered) in juices of three different common edible fruits *i.e*. apple (*Malus domestica*), moushmi (*Citrus medica*) and amla (*Emblica officinalis*). All reactions were carried out at room temperature (15 ºC) and pressure (738 mm of Hg) *in vitro* for 48 and 72 h. Attempts have been made to solubilize the whole stone and powdered stone by treating them with juices of different fruits for 48 and 72 h. This comparative study showed that the solubility of renal stone ingredients of smaller size stone was more than bigger sized stone and powdered form was much more than the whole stone. The dissolving properties of moushmi juice was comparatively much more than apple and amla juice. Apple juice had least dissolving effect. This short-term study suggests that moushmi juice would be helpful in designing of herbal preparation for dissolving, at least partially 'the urinary stones', however, additional studies are needed to evaluate the role of such kinds of fruit's juice in long-term preventive and therapeutic management of nephrolithiasis.

Key Words: Kidney stones, Solubility, Dissolution, Apple (*Malus domestica*), Moushmi (*Citrus medica*) and Amla (*Emblica officinalis*).

INTRODUCTION

Urinary stones are firm and hard structure which can grow from crystals formed in the urinary systems. They cause pain in the back or the flanks which can radiate down into the groin area. Kidney stones are typically over the age of 30 years and made up of over 75-80 % of calcium oxalate and are caused by a high concentration of calcium in the urine. Many conditions can lead to this high concentration but most common is diet, a diet that is low in fibre, high in refined carbohydrates, alcohol, animal protein, fats, salt and calcium and vitamin D rich foods is linked

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with the formation of kidney stones. About 10-15 % of adults in the United States, are suffered with urinary tract stone[1]. The incidence rate is much more in those zones where chances of dehydration are high and climates are hot *i.e*., 20-25 % in the Middle East. It has been found that recurrence rates are about 10 %/year, totaling of 50 % over a 5-10 year period and 75 % over 20 years[2]. Incidence of urinary stone formation are approximately 4 times more in men than that of women. According to the recent survey it has been seen that the increasing trend of urinary stones in pediatric age group. The most common type of kidney stone is composed of calcium oxalate crystals, which is found in about 80 % of cases[2] and the factors that enhance the precipitation of crystals in the urine are also responsible for the formation of renal stones. Many patho-physiological conditions promote the formation of stones. Common belief has long held that consumption of too much calcium or calcium containing diets could promote the development of calcium oxalate kidney stones. However, the recent evidence suggests that the consumption of low-calcium diets is actually associated with a higher overall risk for the development of kidney stones[3-5]. This is perhaps related to the role of calcium in binding ingested oxalate in the gastrointestinal tract. As the amount of calcium intake decreases, the amount of oxalate available for absorption into the bloodstream increases; this oxalate is then excreted in greater amounts into the urine by the kidneys. In the urine, oxalate is a very strong promoter of calcium oxalate precipitation, about 15 times stronger than calcium[6].

Diet can help in the prevention of kidney stones and it is best to avoid oxalate-rich foods such as beets, beans, blueberries, celery, grapes, chocolate, strawberries, spinach, rhubarb, tea, nuts, bran, almonds and peanuts[7-9]. It is also best to avoid calcium supplements and foods which cause increased levels of urinary calcium such as animal protein from meat, dairy products, fish and poultry. It is for this reason that vegetarians suffer less from kidney stones. Potassium reduces urinary calcium excretion and by eating fruit and vegetables which are high in potassium the risk of suffering from kidney stones is reduced[10,11]. Citrate containing substances *i.e*., potassium citrate as urine alkalizer, may also be used in kidney stone prevention. They are not only increases the urinary pH (makes it more alkaline), but also increases the urinary citrate level, which helps in reduction of calcium oxalate crystal aggregation. Measurements of food oxalate content have been difficult and issues remain about the proportion of oxalate that is bio-available, *versus* a proportion that is not absorbed by the intestine. Restriction of oxalate-rich foods plus maintenance of an adequate intake of dietary calcium reduces stone formation. Drinking plenty of citrus fruit juices especially orange, blackcurrant and cranberry, may reduce the risk of urinary stones formation this is because citric acid (citrate) protect against kidney stone formation[12-14].

The present study is carried out to investigate the comparative solubility of urinary stones (whole stone of different sizes and powdered stone) in juices of three different kinds of common edible fruits such as apple, moushmi and amla.

EXPERIMENTAL

Renal stones of two patients (Mr. Rahiman and Mr. Manzoor having operated on 13th Sept. 2006 and 28th Sept. 2006, respectively at Hai Medicare and Research Institute, Patna) was collected and washed properly with distilled water. Each stone was suspended separately in 20 mL of N/10 NaCl solution for 24 h. Samples filtered and washed with distilled water. Dried in air oven at 80 ºC for 2 h and cooled down. Three different types of samples were prepared for each fruit juice. First and second samples having the whole stone of different weight and third sample, powdered stone were suspended in each 25 mL of fresh juice of different edible common fruits *i.e*. Apple (A1, A2 and A3), moushmi (B1, B2, and B3) and amla (C1, C2 and C3) and kept for 48 h at room temperature (15 ºC) and pressure (738 mm of Hg) (whole procedure was done in month of December). Stones were again filtered, washed with distilled water, dried and weighed out. Filtrates were again suspended in 25 mL of each fruit juices for further 24 h. Stones were again filtered, washed with distilled water, dried and weighed out.

RESULTS AND DISCUSSION

The whole procedure and reaction *in vitro* have been carried out at room temperature, 15 ºC . Our main aim is to break the hard crust of urinary stone by dissolving part of it and once a portion of crust is gone, the stone become susceptible to attack by inhibitors presents in juices of different common edible fruits.

Keeping all these view, we have endeavored to solubulize these ingredients of kidney stone of different forms and weight with extract of natural sources containing inorganic and organic weak acids.

Weight reduction are observed following the suspension of urinary stone of different forms *i.e*., bigger single stone *versus* smaller single stone *versus* powdered stone in juices of different common fruits in 48 and 72 h (Table-1).

Solubility difference (g/25 mL of fruit juice) of urinary stone of whole single stone (bigger and smaller size) and powdered stone are 0.0027, 0.0033 and 0.0130 *versus* 0.0032, 0.0039 and 0.0169 in apple juice; 0.0106, 0.0109 and 0.0135 *versus* 0.0196, 0.0199 and 0.0143 in moushmi juice and 0.0033, 0.0028 and 0.0284 *versus* 0.0037, 0.0034 and 0.0298 in amla juice in 48 h and in 72 h, respectively (Table-2, Fig. 1).

Percentage solubility of urinary stone of whole single stone (bigger and smaller size) and powdered stone are 0.40, 1.01 and 2.27 % *versus* 0.48, 1.19 and 2.95 % in apple juice; 2.04, 5.08 and 10.67 % *versus* 3.77, 9.27 and 11.30 % in moushmi juice and 1.40, 1.35 and 9.02 % *versus* 1.57, 1.91 and 9.47 % in amla juice in 48 and in 72 h, respectively (Table-3, Fig. 2).

It was also found that the difference in weight of whole stone (bigger and smaller) and powdered stone, before and after the treatment in juices, gave a clear indication of dissolution of some ingredient of the stone, which remained in the solution. It has been observed that the percentage solubility of stone ingredient was much more

TABLE-1
OBSERVED DATA FOLLOWING EXPERIMENT WITH URINARY STONE IN JUICES OF DIFFERENT COMMON EDIBLE FRUITS

Natural product	Sizes of stone	Sample No.	Wt. of whole stone (g)	Wt. remained after N/10 NaCl treatment (g)	Wt. remained after 48 h treatment with juice (g)	Wt. remained after 72 h treatment with juice (g)
			(a)	(b)	(c)	(d)
Apple	Bigger single stone	A1	0.6722	0.6703	0.6695	0.6690
	Smaller single stone	A2	0.3265	0.3245	0.3232	0.3226
	Powder stone	A3	0.5720	0.5697	0.5590	0.5551
Moushmi	Bigger single stone	B1	0.5197	0.5115	0.5091	0.5001
	Smaller single stone	B2	0.2146	0.2062	0.2037	0.1947
	Powder stone	B3	0.1265	0.1241	0.1130	0.1122
Amla	Bigger single stone	C1	0.2352	0.2330	0.2319	0.2315
	Smaller single stone	C2	0.1779	0.1761	0.1751	0.1745
	Powder stone	C3	0.3148	0.3053	0.2864	0.2850

TABLE-2
SOLUBILITY DIFFERENCE OF URINARY STONE IN JUICES OF DIFFERENT EDIBLE FRUITS

Time period	Apple			Moushmi			Amla		
	Bigger single stone	Smaller single stone	Powdered stone	Bigger single stone	Smaller single stone	Powdered stone	Bigger single stone	Smaller single stone	Powdered stone
In 48 h (a-c)	0.0027	0.0033	0.0130	0.0106	0.0109	0.0135	0.0033	0.0028	0.0284
In 72 h (a-d)	0.0032	0.0039	0.0169	0.0196	0.0199	0.0143	0.0037	0.0034	0.0298

TABLE-3
PERCENTAGE SOLUBILITY* OF URINARY STONE/25 mL OF JUICES OF DIFFERENT EDIBLE FRUITS

Time period	Apple (%)			Moushmi (%)			Amla (%)		
	Bigger single stone	Smaller single stone	Powdered stone	Bigger single stone	Smaller single stone	Powdered stone	Bigger single stone	Smaller single stone	Powdered stone
In 48 h (a-c)	0.40	1.01	2.27	2.04	5.08	10.67	1.40	1.35	9.02
In 72 h (a-d)	0.48	1.19	2.95	3.77	9.27	11.30	1.57	1.91	9.47

*Solubility difference (g/25 mL of juice)/wt. of stone before suspension × 100.

in juice of moushmi and amla than apple juice in descending order *i.e.*, powdered stone > smaller size stone > bigger size stone in both time interval 48 and 72 h. Results of current study clearly show that dissolution of ingredient of powdered stone is much more than whole stone while dissolving properties of fruit juice for urinary stone is significantly higher in moushmi juice and least or negligible in apple juice.

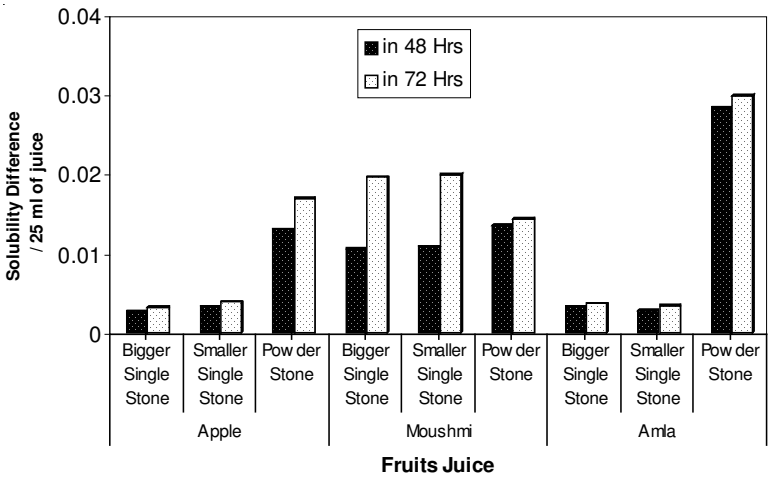

Fig. 1. Solubility difference of renal stone in juices of different common edible fruits (natural sources)

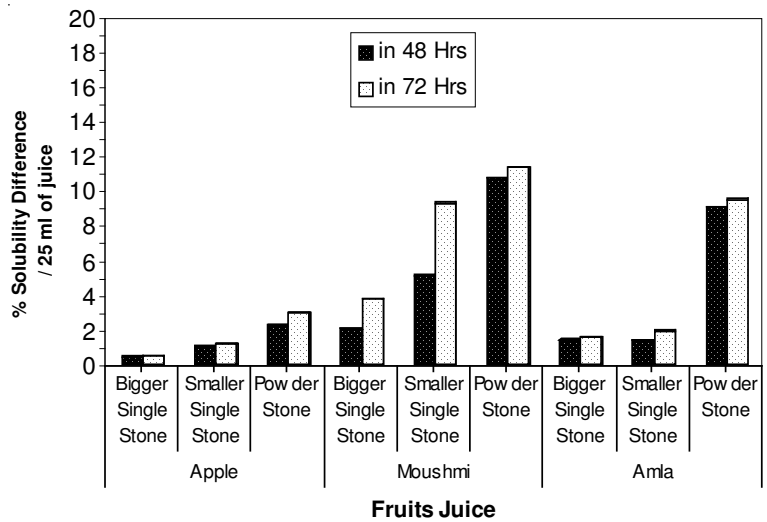

Fig. 2. Percentage solubility difference of renal stone in juices of different common edible fruit (natural sources)

Conclusion

Outer surface of urinary stone is much more hard and stubborn so any kinds of inhibitors are unable to solubulize these stone easily. Dissolution properties of fruit's juices for urinary stone are proportionate to the concentration of organic acids (hydroxy-acids *e.g.*, citric acid) *i.e.*, moushmi juice has more than amla juice and much more than apple juice. Apple juice has least dissolving properties for urinary stone particularly bigger sized stone. The solubility nature of stone is inversely proportionate to the size of stone that is, powdered stone is comparatively much more soluble than whole stone (bigger or smaller size) but in compare between bigger and smaller sized stone, smaller sized stone has slightly more soluble than the bigger sized whole stone. Such studies would be helpful in designing of herbal preparation for dissolving, at least partially 'the urinary stones'.

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