2. REVIEW OF LITERATURE

The literature available on the work done so far in abroad and in India was reviewed as per the objectives of the present study and has been presented under the following sections.

2.1 Prevalence of kidney stones
2.2 Signs and symptoms of kidney stones
2.3 Recurrence of kidney stones
2.4 Risk factors of kidney stones
2.5 Anthropometry
2.6 Dietary pattern
2.7 Nutrition knowledge and education/counseling
2.8 Management of kidney stones

2.1 Prevalence of kidney stones

2.1.1 Prevalence world wide

Curhan et al. (1996) worked on the effect of 21 different beverages on kidney stones and reported incidences of kidney stones in 753 men out of 45,289 men (40-75 years) during six years of follow up study.

In another study by El. Rashid et al. (1997) on epidemiological profile, mineral metabolic pattern and crystallographic analysis of urolithiasis in Kuwait, it was reported that the average annual incidence of new stone formation in Kuwait patients was 23.9 per one lakh population. The incidence was only 6.9 per one lakh population in those from pediatric age group, 33.4 in adults and 73.6 in the elderly.

Hirvonen et al. (1999) studied nutrient intake and use of beverages and risk of kidney stones among Finnish male smokers and reported that out of 27001 male smokers, 329 males were suffering from kidney stones. Lewandowski et al. (2001) reported more incidences of kidney stones in black South Africans than in white South Africans.
Sritippayawan et al. (2009) conducted a study on genetic contribution to kidney stones in North Eastern Thai population. Total 1034 subjects including 135 patients with kidney stones, 551 family members and 348 villagers were included in this study. It was reported that 116 out of 551 family members (21.05%) and 23 of the 348 villagers (6.61%) were suffering from kidney stones. The relative risk of the disease among family members was 3.18.

Basiri et al. (2010) worked on the demographic profile of urolithiasis in Iran and reported 6089 imaging proven cases of stones out of 117,956 cases.

2.1.2 Prevalence in India

Kumari and Dahiya (1999) conducted a study on socio-economic, personal and family profile along with food habits of 25 patients with kidney stones in the Hisar city of Haryana. From survey, it was reported that high incidences of kidney stones were among individuals belonging to large family size. High incidences of kidney stone were among urban people (66.67%) as compared to rural people (33.33%).

Bharathi and Amirthaveni (2007) conducted a comparative study on 24 hour urinary composition between urinary stone formers and healthy volunteers from five cities of Tamil Nadu namely Coimbatore, Vellore, Madurai, Nagercoil and Tirunelveli. It was reported that there was a considerable increase in incidence of kidney stone cases year by year (from 1869 to 3084) in Coimbatore while other admission centres of other cities showed marginal increase in admission rates.

2.2 Signs and symptoms of kidney stones

Bharathi and Amirthaveni (2007) compared 24 hour urinary composition of urinary stone formers and healthy volunteers of Tamil Nadu. Out of 100 patients, 88 per cent expressed that they suffered from renal colic, 38 per cent had nausea and vomiting along with flank pain and 12 per cent had fever. 72 per cent experienced incomplete voiding and 43 per cent had haematuria while six per cent experienced burning micturition and 16 per cent suffered from oliguria.
2.3 Recurrence of kidney stones

Hiatt et al. (1996) trailed the effect of low animal protein and high fiber diet in the prevention of recurrent calcium oxalate kidney stones and reported 5.6 recurrence rate in intervention group.

El-Reshaid et al. (1997) conducted a study on epidemiological profile, mineral metabolic pattern and crystallographic analysis of urolithiasis in Kuwait and reported that 84 patients out of 421 patients had recurrent stone problem. In another study by Bharathi and Amirthaveni (2007) on urinary composition of urinary stone formers and healthy volunteers of Tamil Nadu, it was reported that out of 700 stone formers selected, 214 (30.6 per cent) were recurrent stone formers. Out of these 214 stone formers 86.9 per cent were males and 13.1 per cent were females.

2.4 Risk factors of kidney stones

Eating habits, alcohol consumption and smoking act as risk factors in kidney stone formation (Zechner et al., 1988). In addition to these personality traits, emotional status, exercise, pulmonary ventilation and dietary habits are also responsible for influencing pH which act as a potentiating risk factor in kidney stone formation (Murayama and Taguchi, 1993). According to Anonymous (2008), factors that could affect kidney stone incidences are age, gender, race, diuretic use, low fluid intake and low urine volume.

2.4.1 Age

Curhan et al. (1993) while working on effect of calcium and other nutrients on risk of symptomatic kidney stones reported the highest incidence of kidney stones in age group of 40-59 years. Bullock et al. (1994) found that men between the ages of 20-50 years appear particularly at risk of kidney stone diseases. It was also reported that most patients with renal calculi were in early adult life, with a peak incidence around 28 years of age.
Vasanthamani and Sushmitha (1997) reported that incidences of kidney stones were more between 20-60 years of age in Coimbatore during a study on the impact of counseling on kidney stone patients in Tamil Nadu.

Kumari and Dahiya (1999) conducted a study on socio-economic, personal and family profile along with food habits of 25 patients with kidney stones in Haryana. The findings showed that the increase in incidences of kidney stones was up to 45 years of age in both males and females followed by decline thereafter except in males belonging to age group of 55-65 years.

In the same year i.e. in 1999, Lifshitz et al. conducted a study on metabolic evaluation of stone disease patients and reported that the peak age of onset of kidney stone formation is during the 3rd and 4th decade of life.

Bharathi and Amirthaveni (2007) compared 24 hour urinary composition of urinary stone formers and healthy volunteers of Tamil Nadu for 24 hours. The results obtained showed that 80.4 per cent of stone formers have had their first stone episode in the 3rd, 4th and 5th decade of their life. Average age at first stone formation was 37.7±12.5 years. The occurrence was 59.9 per cent among 20-40 years of age. The youngest stone patient selected was of 5 years and oldest was 82 years old.

2.4.2 Gender

Vasanthamani and Sushmitha (1997) studied the impact of diet counseling of 100 kidney stone patients of Tamil Nadu. The results showed that out of 100 patients of kidney stones, incidences were more in males (96 per cent) than females.

Similar results were obtained by Kumari and Dahiya (1999). According to their study, the incidence of renal stone was higher (72 per cent) among males than females (28 per cent).

Bharathi and Amirthavani (2007) compared the urinary composition of urinary stone formers and healthy volunteers and reported that out of 700 stone formers in five cities of Tamil Nadu, 214 patients were recurrent stone formers.
out of which 186 (86.9 per cent) were males and rest 28 (13.1 per cent) were females. Among the rest of stone formers, 486 (69.4 per cent) were first time stone formers, of whom 396 (81.5 per cent) were males and 90 (18.5 per cent) were females.

Taylor and Curhan (2007) worked on effect of oxalate intake and risk for nephrolithiasis and found that risk of kidney stones was more in males than females i.e. 1.22 for men and 1.21 for women.

Spivacow et al. (2008) studied metabolic risk factors in children with kidney stones and reported that out of 90 children, male and female ratio was higher towards males i.e. 1.14: 1.00.

2.4.3 Socio-economic status

Socio-economic status includes educational qualification, occupation, socio-economic class as they are inter-related and interdependent.

2.4.3.1 Occupation

Borghi et al. (1993) reported high incidence of kidney stones in marathon runners as sweating and prolong strong muscular exercise is needed for this activity.

Menon and Mahle (1982) indicated that tea factory workers consume large amount of tea and therefore are prone to stone formation since tea leaves are rich in oxalates.

Vasanthamani and Sushmitha (1997) studied the impact of diet counseling of 100 kidney stones patients of Tamil Nadu and reported that among 100 stone patients, 22 were agriculturists, 21 were working in steel plants and 10 subjects were in tea factory while 25 were in business and 22 were professionals.

Kumari and Dahiya (1999) studied socio-economic, personal and family profile along with food habits of 25 patients with kidney stones and reported the highest incidence of kidney stones among housewives (85.7 per cent) than women involved in agricultural jobs.
Bharathi and Amirthaveni (2007) compared urinary composition of urinary stone formers and healthy volunteers of 5 cities of Tamil Nadu. Among 700 selected stone formers, 37.90 per cent were working in hot environment. They were tinkers, welders, mechanics and factory workers. About 16 per cent were unorganized labour force like load men and agriculture coolies who worked directly under sun. 10.7 per cent were drivers, conductors and sales representatives on constant travel while only 7.6 per cent were engaged in jobs which requires continuous sitting like goldsmith, cashier etc. Nearly 72.7 per cent of stone formers worked in environment leading to saturation of stone forming salts in urine. Heavy sweating was present in 59.4 per cent of stone formers which ultimately leads to low urine volume and super saturation of urine.

2.4.3.2 Socio-economic class

Mates (1969) reported high incidences of renal stone disease among service class. Similar results were obtained by Anderson (1972) who reported the highest incidences of kidney stone among upper class.

Kumari and Dahiya (1999) worked on socio-economic, personal and family profile along with food habits of 25 patients with kidney stones. Results showed that 60 per cent of kidney stone patients had nuclear family comprising 4 and above members. Other 40 per cent were with joint family having family composition up to 4 members (8 per cent) and 2-4 members (32 per cent). Majority (72 per cent) of them were residing in full Pucca houses followed by partially Pucca (20 per cent), Pucca (4 per cent) and Kuchha houses (4 percent). High incidences of kidney stones were observed among males educated up to school level (44.4 per cent) followed by graduates (27.70 per cent). The study further revealed that the incidence of renal stones was the highest (44.44 per cent and 71.43 per cent for males and females respectively) in the middle income groups (Rs 6000/- per month). The highest incidence of kidney stones was found among service class (44.44 per cent) followed by business people (33.33 per cent).
Bharathi and Amirthaveni (2007) reported that among 700 stone formers of Tamil Nadu 89.60 per cent were of low and middle income groups. Nearly 23.70 per cent of female stone formers and 28.90 per cent of male stone formers were illiterate. 54 per cent of them were educated up to primary school level. Only 18.7 per cent had higher education.

2.4.4 Heredity

Perez et al. (2001) during a study on epidemiology of urinary lithiasis reported 20.4 per cent patients with kidney stones with a family history. In these cases father was being the most frequently affected relation. Goldfarb et al. (2005) during a twin study of genetic and dietary influences on nephrolithiasis reported 56 per cent heritability of risk for stones out of 7500 male-male twin pairs.

Bharathi and Amirthaveni (2007) during comparison of urinary composition of stone formers and healthy volunteers of Tamil Nadu assessed that among 700 stone formers, 16.4 per cent had the family history of kidney stones. Stone formation has genetic basis and father’s stones are often vested upon their sons. Nearly 34.80 per cent of stone formers were siblings and 33.90 per cent were fathers.

Spivacow et al. (2008) studied the metabolic risk factors in children with kidney stones and found a positive family history in first degree and second degree relatives (46.2 per cent and 32.5 per cent of cases respectively).

Marickar et al. (2009) studied the family history of stone patients. The result obtained showed that out of 2157 selected patients, 349 gave positive history of stone disease (16.18 per cent). Out of these 321 were males and 28 were females. About 80.80 per cent patients had single family history member with stones and rest 19.20 per cent had multiple family members with history of kidney stone disease. It was concluded that stone occurrence was more in patient with history of stone in immediate family members than in distant relatives. Brothers formed the most common group to be involved with stone disease.
Spivacow et al. (2009) during a study on clinical and metabolic risk factor evaluation in 160 young adults with kidney stones found positive history of kidney stone disease in first degree and second degree relatives (32.9 and 34.1 per cent respectively).

### 2.4.5 Personal Habits

Vasanthamani and Sushmitha (1997) studied impact of diet counseling on 100 patients with kidney stones. Results of the study concluded that about 96 patients had habit of taking tobacco, betel leaves, tea or coffee, smoking and alcohol consumption. 60 per cent of patients consumed tea or coffee, 15 per cent were using tobacco and 10 per cent chewed betel leaves with churum which contain more calcium carbonate.

### 2.4.6 Other related diseases and complications

Bohles et al. (1987) worked on urinary factors of kidney stone formation in 86 patients with Crohn’s disease. The concentrations of factors known to enhance calcium oxalate stone formation (oxalate, calcium and uric acid) as well as inhibitory factors of stones (magnesium and citrate) were determined in urine of 86 patients as compared with those of 53 healthy controls. Six patients with Crohn’s disease (Inflammatory bowel disease) already had experienced calcium oxalate stones. The study demonstrated that in patients with Crohn’s disease, the urinary oxalate concentration was higher while urinary magnesium and citrate concentration was lower than normal.

According to Borghi et al. (1993) chronic dehydration can be considered a cause of urolithiasis.

Cappuccio et al. (2000) collected evidences from animal, clinical and epidemiological studies and suggested that the high blood pressure is associated with abnormalities of calcium metabolism. This leads to increased calcium loss, secondary activation of parathyroid gland, increased movement of calcium from bones and finally increased risk of urinary stones.
Baldwin et al. (2003) while working on effect of carbohydrate intolerance on kidney stones in children of Goldfields, postulated that carbohydrate mal-absorption, together with chronic diarrhoea and intra-luminal breakdown of sugars by enteric bacteria may result in chronic metabolic acidosis. This chronic metabolic acidosis can lead to protein catabolism, increased urate excretion and finally to formation of renal stones. According to the author, it is an aetiological factor of renal diseases in the Aboriginal Australians.

Basiri et al. (2010) conducted a study on demographic profile of urolithiasis in Iran. The results of study indicated that the most frequent co-existence diseases with kidney stones were hypertension (15.8 per cent) and diabetes (11.4%). It ranged from 2.8 to 21.3 per cent for diabetes and 6.1 to 30.4 per cent for hypertension compared to 1 to 4.2 per cent and 4 to 7.7 per cent respectively in general population.

2.5 Anthropometry

According to Siener (2005), overweight and associated dietary pattern contributes to the increasing incidence and prevalence of stone disease.

Taylor et al. (2005) reported that BMI was associated with risk of kidney stone formation. For this study, 988 men, 758 older women and 101877 female nurses were selected. Results indicated that the relative risk for men with BMI of 30 or greater versus those with BMI of 21 to 22.9 was 1.33. Corresponding relative risk for the same categories of BMI in older and younger female nurses were 1.9 and 2.09. Waist circumference was also associated with risk of kidney stones.

Duadon et al. (2006) worked on influence of body size on urinary stone composition in 1931 men and women of France. The results of study revealed that 27.1 per cent of male and 19.6 per cent of female stone formers were overweight and 8.41 and 13.5 per cent were obese, respectively. In males, the proportion of calcium stones was lower in overweight and obese groups than in normal BMI groups. The proportion of uric acid stones gradually increased with BMI from 7 per cent in normal BMI to 28.7 per cent in obese subjects. The same
was true in females with a proportion of uric acid stones rising from 6.1 per cent in normal BMI to 17.1 per cent in obese patients. The data provided the evidence that the overweight is associated with a high proportion of uric acid stones in patients less than 60 years of age.

Bharathi and Amirthaveni (2007) compared the urinary composition of urinary stone formers and healthy volunteers of 5 cities in Tamil Nadu. The results showed that out of 700 stone formers, 7.6 per cent of stone formers had BMI below 18.5 and belonged to underweight category and 57.9 per cent were in normal weight category. Rest 34.5 per cent was overweight.

Sinha et al. (2009) reported that patients with stone disease had a significant higher BMI. Therefore obese patients, especially those with a family history of stone disease should be counseled on weight loss.

2.6 Diet Pattern

Tur et al. (1991) reported that inadequate intake of fluids or excessive intake of foods rich in oxalates, sodium, calcium or animal protein act as a risk factor in kidney stone formation.

2.6.1 Dietary Habits

2.6.1.1. Dietary Habits of kidney stone patients

Pendse and Singh (1986) reported that the incidence of kidney stones in vegetarian males was high i.e. 77.78 per cent as compared to non vegetarian males it was 22.22 per cent. Similarly, the incidences in vegetarian females were high (compared to non vegetarian females (17.29 per cent).

Curhan et al. (1993) during a study on dietary calcium and other nutrients and risk of symptomatic kidney stones, reported that intake of animal proteins was directly associated with risk of stone formation in 505 cases of kidney stones.

Masai et.al (1995) reported that carbohydrates and fats are positively correlated with urinary oxalate excretion in stone formers while according to Parivar et al. (1996) diet influences urinary constituents and pH which may affect stone nucleation.
Vasanthamani and Sushmitha (1997) studied the impact of dietary counseling of 100 kidney stone patients of Tamil Nadu. The results of study revealed that about 87 per cent patients were non vegetarian while only 13 per cent were vegetarians. The frequency of consumption of green leafy vegetables, especially agathi and drumstick leaves (which are excellent sources of calcium) were high among studied patients. Tomato and cabbage were also consumed more frequently (which are rich in oxalates). Among non vegetarians, eggs and flesh foods were consumed every day or frequently. About 40 per cent of patients consumed ½ to 2 liters of milk daily which is a point of serious concern in development of kidney stones.

Kumari and Dahiya (1999) studied the socio-economic personal and family profile along with food habits of 25 patients with kidney stones of Haryana. The findings of the study revealed that incidence of kidney stones was higher in vegetarians (80 per cent) than in non-vegetarians.

Massey (2001) reported that soya contains oxalates which cannot be metabolized by the body and excreted only through urine. These oxalates bind to calcium and form kidney stones. Diet has a key role in determining urinary chemistry and can influence the risk of stone formation (Rodgers and Lewandowski, 2002).

Pak (2004) reported that dietary factors for kidney stone formation includes a high intake of animal proteins, oxalate, sodium, a low intake of fluids and potassium containing citrus products.

Gasinska and Gajeswka (2007) investigated the feeding habits of 22 adult patients (12 men and 10 women) with kidney stones from Poland to determine the main food sources of oxalate. It was reported that daily dietary oxalate intake was 354±261 mg in men and 406±265 mg in women. The main dietary sources of oxalates were tea and coffee (80-85 per cent). It was concluded that frequent consumption of oxalate rich foods such as tea and coffee is a significant risk factor for kidney stones.
Liebman and Murphy (2007) suggested that black tea derived oxalate is of low bioavailability and may be a risk for the development of kidney stones.

Saldana et al. (2007) reported that drinking two or more colas per day is associated with diabetes, hypertension and kidney stones.

2.6.1.2 Nutrient intake and other related factors

Jeffery et al. (1986) worked on nutrient intake and supplementation in the United States (NHANES II) and reported that intake of calcium and B-complex vitamin was more in younger age persons. Also males had more nutrient intake than females.

Kawatra and Sehgal (1998) reported a positive association of nutrient intake (Energy, Protein, Vitamin C and Iron) with increase in income while studying the nutrient intake of lactating mothers from rural and urban areas of Hisar. Intake of these nutrients was increasing with the increase in income.

Starkey et al. (1999) studied nutrient intake of food bank users of Montreal, Quebec, Canada with respect to household size, smoking, education, country of birth and frequency of food bank use and reported higher intake of energy, protein, fat, calcium, magnesium and zinc in males than females.

NNMB (2002) surveys on time trends in dietary intake and nutritional status of the rural and urban population of eight states indicated the high intake of cereals and millets in low socio-economic groups. Dietary diversification was also reported with the increase in income as result of which the intake of energy, proteins and total fats was also increasing.

Sarda et al., (2005) worked on pattern of calorie consumption in rural households of Raipur district of Chattisgarh. Results obtained were analyzed by regression analysis which was positive indicating that with the increase in the annual income there was increase in calorie intake.

Bharathi and Amirthaveni (2008) during a study on nutritional intervention comparison of urinary composition of stone formers and healthy volunteers of Tamil Nadu reported nutrient intake per day of 250 kidney stone former of age group 20-50 years as energy-2502 kcal, carbohydrate-517.1g, proteins-54.6g and calcium-343.4mg.
Orewa and Lyangbe (2009) worked on determinants of daily food calorie intake among rural and low income urban households in Nigeria. The result of the study revealed positive relationship between daily per capita calorie intake with respect to age, sex and income. There was more calorie intake in males with high income as compared to females. Also daily per capita calorie intake of household members was increasing with their age.

2.6.2 Fluid Intake

Whitson et al. (1993) reported that disorders of metabolism, ion transport with in intestinal tract and reduced fluid intake are aetiological risk factors of kidney stones. Inadequate fluid consumption decreases total urinary volume thereby increasing the concentration of stone forming salts.

Vasanthamani and Sushmitha (1997) while studying impact of diet counseling on 100 kidney stone patients reported that 84 per cent patients consumed less than one litre of water per day, which is another causative factor of urinary calculi.

Caudarella et al. (1998) reported that low urine volume induced by excessive body fluid loss or insufficient dietary fluid intake represents an important risk factor for kidney stones. These distributions may influence the physiochemical relationships in urine creating an environment for formation of salt. In general, the crystallization of stone forming salt owes to an abnormal urinary composition i.e. higher in crystallization promoters like calcium, oxalates, uric acid or low in inhibi tors (citrate, glycoaminoglycans and kidney proteins such as nephrocalcin or both). Urinary calculi are almost composed of substances normally excreted in urine, together with a certain amount of protein material including blood protein. On rare occasions foreign bodies may form nucleus of the stone.

Bharathi and Amrithaveni (2008) studied impact of nutritional intervention of urinary composition of 250 stone formers of Tamil Nadu. The findings of study showed that the fluid intake of stone formers was significantly lower. Lower volume induced by insufficient dietary fluid intake is an important risk for kidney stones. The study further revealed that drinking 2500 ml/day prevented recurrence of stones in 70 per cent of calcium stone formers.
2.6.3 Salt Intake

Muldowney et al. (1982) reported that intake of sodium is associated with increased risk of stone formation presumably because of increased urinary calcium excretion. Similar results were obtained by Whitson et al. (1993). According to him high salt diets can increase urinary calcium and enhance the potential for sodium urate induced calcium oxalate stones.

Burtis et al. (1994) assessed relative importance of dietary factors in causing hyper-calciuria in 282 patients with calcium oxalate kidney stones. The findings showed that dietary sodium is important as dietary calcium and more important than dietary carbohydrates, proteins, phosphorous or oxalates in contributing to calcium excretion. Because when calcium free diet was given to 124 kidney patients even then urinary calcium excretion was increased by 0.0193 mmol/mmol sodium excretion. Results concluded that dietary habits, particularly high sodium intake may contribute to hyper-calciuria in patients with calcium oxalate stones even on calcium free diet.

Bharathi and Amrithaveni (2008) worked on impact of nutritional intervention on urinary composition of stone formers and reported higher intake of sodium chloride among stone formers.

2.7 Nutrition Knowledge and Education/Counseling

Vasanathamani and Sushmitha (1997) evaluated the impact of diet counseling of 100 patients with kidney stones of Tamil Nadu. The results indicated that intensive diet counseling resulted in changed attitude of patients towards healthy practices. The serum calcium, phosphorous and oxalate levels reduced after diet counseling. The values of urinary calcium, phosphorous and oxalates were 242.20±23.16 mg/day 1423.3±153.21 mg/day and 315.9±18.07 mg per day, respectively before diet counseling which reduced to 157.60±10.62 mg/day, 1004±81.03 mg/day and 205.4±9.11 mg/day for calcium, phosphorous and oxalates respectively after diet counseling. The results concluded the beneficial effects of diet counseling.
Grover and Singh (2004) studied training needs of rural mothers in nutrition, health and environmental sanitation in different agro climatic regions of Punjab and reported that education of mothers was significantly (At one per cent level) positively co-related ($r= 0.37$) with their knowledge regarding nutrition, health and environmental sanitation. Such relationships suggested that formal schooling enables the mother to learn and acquire knowledge of nutrition, health and environmental sanitation.

Lin and Lee (2005) studied the nutrition, knowledge, attitudes and dietary restriction behaviour of Taiwanese elderly and reported that elderly men with a higher education level living in less remote areas were better in nutrition knowledge related to their health care attitudes, general eating attitudes and high fat restriction behaviour. The results of the study also suggested that nutrition education programmes should consider low education levels of respondents.

### 2.8 Management of kidney stones

#### 2.8.1 Dietary Management

Mitwalli (1989) worked on control of hyperoxaluria with large doses of pyridoxine in 12 patients with kidney stones. Pyridoxine (250 to 500 mg by mouth/ day) was given to 12 patients suffering from recurrent calcium oxalate kidney stones and hyperoxaluria. After 3 to 6 months urinary oxalate excretion was decreased. Eight patients showed no evidence of stone disease. These findings showed that pyridoxine is useful in management of elevated urinary oxalate excretion in patients with recurrent calcium oxalate kidney stones.

Massey and Suttan (1993) worked on modification of dietary oxalate and calcium to reduce urinary oxalates in 13 hyperoxaluric patients with kidney stones. After giving 3 types of diet i.e low calcium diet (Diet A) for 6 days, normal oxalate diet (Diet B) for 6 days and high oxalate diet (Diet C) for 6 days, urinary calcium and oxalate levels were estimated. The results showed that urinary oxalates were significantly lower on consumption of Diet ‘A’ and ‘B’ than Diet ‘C’. It was concluded that patients with calcium oxalate stones and hyperoxaluria should restrict dietary oxalates.
Peshin and Singla (1994) reported that horse gram seeds (*Dolichas biflorus*) contain inhibitors of crystallization which are water soluble, heat stable, polar, non-tannin and non protein in nature. They have useful effect on calcium phosphate kidney stones. They are used to treat kidney stones in India and are a constituent of Ayurvedic medicine i.e cystone because of its anticalcifying property.

Hiatt *et al.* (1996) advised to follow a low animal protein, high fiber, and high fluid diet to avoid stone formation as there is no advantage on increasing fluid intake alone. While Curhan *et al.* (1999) found that a high intake of pyridoxine was inversely associated with the risk of stone formation.

Hirvonen *et al.* (1999) observed beneficial effects of potassium, magnesium and beer on kidney stones. According to him beer consumption is inversely associated with the risk of kidney stones. Each bottle of beer consumed/day was estimated to reduce risk by 40 per cent. Similar beneficial effects of beer were reported by Guldborg (2000).

He and MacGregor (2001) reported reduction in urinary calcium excretion on increase in potassium intake. Savage (2002) suggested that it would be prudent for stone formers to limit their oxalate intake. While benefits of rice bran against kidney stones were reported by Haixiu *et al.* (2003).

McHarg *et al.* (2003) studied the influence of cranberry juice on urinary risk factor for calcium oxalate kidney stone formation. Urinary oxalate and urinary phosphate values were reduced when 1500 ml cranberry juice was given to 10 South African men for 2 weeks while, there was increase in urinary oxalate excretion. The results of the study concluded that the cranberry juice has anti-lithogenic property.

Siener and Hesse (2003) worked on effect of vegetarian and different omnivorous diets on urinary risk factors for uric acid stone formation. Three types of diets viz. western or self selected flesh diet, a balanced omnivorous diet and a lacto vegetarian diet was provided to 10 healthy male subjects. After five consecutive days reduction in uric acid crystallization by omnivorous and ovo-
lacto vegetarian diet was 85 per cent and 93 per cent respectively, while risk of uric acid crystallization was high on western diet. The results concluded that intake of balanced lacto-ovo vegetarian diet (contains moderate animal proteins and purines, adequate fluids and high alkali load from fruit and vegetables) was beneficial in lowering risk of uric acid crystallization.

Curhan et al. (2004) added that phytate is a new, important and safe addition to options available for stone prevention.

Weiven and Leibman (2005) assessed effect of different cooking methods on vegetable oxalate content. It was reported that boiling is more effective (30-87 per cent) than steaming (5-53 per cent) for raw vegetables rich in water soluble oxalates. Since soluble oxalates are absorbed better than insoluble oxalates and cause kidney stones, use of boiling may be an effective measure for decreasing predisposed to kidney stones.

Bharathi and Amirthaveni (2008) conducted a study on impact of nutritional intervention on urinary composition of stone formers. 50 stone formers (in three groups) were given 5 g of sodium, 300 mg of pyridoxine and 4300 mg/dl citrate through 2000 ml lemon juice for 3 months. At the end of study period, results concluded that stone formers should adopt a low sodium diet to decrease urinary calcium excretion. A regular consumption of pyridoxine is helpful in reduction of urinary oxalate excretion. While, consumption of lemon juice can increase urinary citrate excretion which is an inhibitor of stone formation.

### 2.8.2 Herbal Management

Girl and Kumaravel (1980) reported several medicinal plant juices like banana stem, pumpkin seeds and rice bran in treatment of kidney stones.

While Prachi et al. (2009) worked on use of medicinal plants of Muzaffarnagar district in treatment of urinary tract and kidney stones and reported use of carrot, decoction of banana, decoction of female inflorescence and immature cob of maize against kidney stones.