INTRODUCTION

The primary function of calcium is to form the structure of bones and teeth. Bone tissues contain more than 99 per cent of the total body calcium. Hence, calcium intake is the predominant dietary factor in determining bone strength and maintenance of bone structure (Flynn 2003; Piaseu et al., 2002; Prentice, 2004). The remaining calcium stores are found in the cells of the soft tissues (0.91%), in blood stream and extracellular fluid (0.1%).

Bone tissues act as a reservoir for calcium. Calcium is involved in variety of other functions in the body such as cellular and neuromuscular functions that involve nerve conduction and muscle contraction. A diet low in calcium or deficiency of calcium in the body does not impair the cellular and neuromuscular functions but draw calcium from the bones to ensure these processes. Therefore, bone health is adversely compromised (Badenhop et al., 2004; Flynn, 2003; Kass, 2004).

The adult skeleton contains about 1kg of calcium and is in equilibrium with plasma calcium at a concentration of about 9-10.4mg per 100ml (Smith, 2001). Loss of calcium from the body occurs daily through urine, feaces as well as insensible loss (Bhatia 2008). Insensible loss includes losses from skin, nails and hairs that accounts about 40-80mg calcium loss per day (Charles et al., 1983). In adults the minimum urinary loss is up to 140mg/day (Bhatia, 2008). Therefore, a constant supply of calcium through diet is necessary.

Inadequate intake of dietary calcium from food and supplements results in hypocalcaemia. Symptoms of hypocalcaemia include numbness and tingling in the fingers, muscle cramps, convulsions, lethargy, poor appetite and abnormal heart rhythm (Weaver et al., 2006). Dietary insufficiency of calcium over a long period can lead to
porous and fragile bones as well as tooth decay.

The serious complications of calcium deficiency reported by Albright et al. (1948) were rickets and osteomalacia. Nordin (1960) mentioned osteoporosis as the most prevalent result of calcium deficiency.

Osteoporosis is a systemic skeletal disease distinguished by low bone mass and microarchitectural deterioration of bone tissue which consequently increases bone fragility and susceptibility to fracture (Consensus Development Conference, 1993). Osteoporosis is considered as a serious public health concern which affects more than hundred million people worldwide (Cooper et al., 1992). According to Reid et al. (1995) one third of all women experience osteoporosis related fractures in their lifetime.

NIH (2000), stated that osteoporosis is a disorder characterized by porous and fragile bones which effecte more than 10 million U.S. adults, 80 per cent of whom were women and another 34 million had osteopenia or low bone mass which precedes osteoporosis. According to Indian Menopause Society (2008), osteopenia and osteoporosis are significant in Indian women. Moreover, 35-40 per cent of women between 40 and 65 years have been detected to suffer from osteopenia whereas 8-30% suffers from osteoporosis from small sample studies. All women over 65 years have been found to have either osteopenia or osteoporosis (Unnin, 2008).

Alekel et al. (1999) reported lower dietary intake of calcium, lower bone mineral density and greater osteoporotic risk in Indian premenopausal women. Further greater occurrence of osteoporosis in Indian postmenopausal women was suggested by Indumati et al. (2004).

This deteriorating disease is a major public health concern with recent estimates suggesting that 10 million Americans have osteoporosis and another 34 million have low bone mass i.e.
osteopenia (A report of the Surgeon General, 2009). Unless fracture occurs, many individuals are unaware they have osteoporosis due to a lack of symptoms.

Osteoporosis is diagnosed by assessing Bone Mineral Density (BMD). In 1994, the World Health Organization (WHO) established diagnosis guidelines for osteoporosis. T-scores of -1 to -2.49 at any of the diagnostic sites (lumbar, spine, neck or femur) indicate osteopenia. T-scores of -2.5 or below indicate osteoporosis.

The most important single cause of osteoporosis is probably menopause which is accompanied by an unequivocal and sustained rise in obligatory urinary calcium loss of about 30mg/day (Morris et al., 1991; Ebeling et al., 1994). Calcium absorption certainly does not increase at this time and probably decreases. This extra urinary calcium represents a negative calcium balance which is compatible with the average bone loss of about 0.5-1.0% /year after menopause (Heaney et al., 1989).

Menopausal status is an important component of osteoporosis detection. Although bone loss begins in premenopausal women, the rate of bone loss accelerates during the perimenopausal time period. As a result, the majority of bone loss occurs during the perimenopausal time period and continues into the postmenopausal time period (Chapurlet et al., 2000; Liao et al., 2002). Perimenopause can last anywhere from a few months up to 4-5 years (Klein et al., 1988). Natural menopause occurs between the ages of 40-55 years in most women. In the United States, the average age of menopause is 51.3 years (Mckinlay et al., 2002). Very few studies have tried to analyse the mean age at menopause between 44 to 47 years in India (Singh et al., 1980; Sharma et al., 1985; Randhawa et al., 1987).

Nutrition plays an important role in the development and maintenance of bone mass as well as pathogenesis, prevention and treatment of many chronic diseases including osteoporosis (Jasminka
et al., 2000). Optimal peak bone mass could be achieved with adequate calcium intake which is necessary for prevention of osteoporosis (Cumming, 1990; Welton et al., 1995). An individual may better withstand natural periods of bone loss during aging and menopause by maximizing peak bone mass during the first three decades. Strategies for osteoporosis prevention targeted for young women and women in midlife will ideally allow women to pass through menopause and into older age with high bone mineral reserves.

Calcium supplementation has been shown to have a positive effect on bone mineral density in postmenopausal women (Shea et al., 2002). Heaney et al. (1978) showed through calcium balance studies in premenopausal women that a minimum of 1,500mg of calcium daily was needed to achieve at least a non negative calcium balance. Reid et al. (1995) found that calcium supplements of 1g/day reduced bone loss by almost 40 per cent in late post menopausal women.

Storm et al. (1998) showed that calcium supplementation prevented seasonal bone loss in elderly women living in North America. Moreover, calcium supplements of 750mg/day prevent loss of bone mineral density (BMD) as reported by Peacock et al. (2000).

Nutritional deficiencies can be prevented or tackled more effectively if along with supplementation nutrition education is also imparted. Main aim of nutrition education is to improve nutritional knowledge and consumption among women of all ages. In addition to this, symptoms and consequences of under nutrition or specific deficiencies such as calcium can be prevented through health education programs in health facilities, media and public information campaigns. This fact has also been reported by Kapur (2001) stating that nutrition education may help to improve the diet appreciably.

Abdel et al. (2003), Breacher et al. (2002) and Chang (2006) reported that community based educational programs proved to have profound effect on improvement of the knowledge and behavior
related to osteoporosis and its care. Hameed et al. (2008) found that Health Educational Intervention Program among Egyptian female employees in National Research Center proved effective for raising their knowledge about osteoporosis.

The main cause of concern regarding calcium deficiency is osteoporosis in pre and postmenopausal women. Moreover, Calcium has been identified as a nutrient which many individuals are lacking in their diets. There is no authentic data to our knowledge about the calcium intake patterns and effect of nutritional calcium supplementation in calcium deficient women of different physiological states in District Kurukshetra (Haryana) is available. Therefore, the present study has been undertaken with the following objectives:

1. To determine calcium content in commonly edible foods.
2. To evolve calcium rich recipes using indigenous calcium rich food stuffs.
3. To assess the effect of nutritional calcium supplements on calcium deficient women of different physiological states (normal, premenopausal and postmenopausal).
4. To explore the effect of nutrition education on calcium deficient women of different physiological states (normal, premenopausal and postmenopausal).
5. To examine the combined effect of nutritional calcium supplements and nutritional education on calcium deficient women of different physiological states (normal, premenopausal and postmenopausal).