SECTION I
INTRODUCTION
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Millets are perhaps the world's earliest food plants used by humans, and certainly the first cereal grain that was used for domestic purposes. They are of great local importance as staples and as reserve crops in marginal areas. Millets have been cultivated since prehistoric times in regions of North Africa and Central Asia, though its origin is ambiguous. Most millet is produced in Asia and Africa. In Europe and the United States, millet is grown mainly as forage for poultry and as bird feed (Robert Ronzio 2004).

Over the last 50 years, the share of ‘Coarse grains’, which include pearl millet, sorghum, maize, finger millet, barley and 5 other millet species known as ‘Small Millets’, in terms of total area has registered 25.3% decline from 38.83 Mha. (1949-50) to 29.03 Mha. (2004-05). In spite of this, several communities in the dry regions having known the food-qualities of millets over generations continue to include a range of millets in the traditional cropping patterns, which recognize millets as an essential part of the local diet.

Millets are nutritionally comparable and even superior to major cereals in terms of energy value, proteins, fat and minerals. They are also good sources of phytochemicals (phenolic acids, lignans and phytoestrogens). Phenolic acids (p – coumaric acid and vanillic acids) that are present in the bran layer of the grains (Qureshi et al 2000). Finger millet (Eleusine corucana) commonly known as ‘ragi’ in India is an important staple for people of south India. It is the third most important millet in India, next to sorghum and pearl millet, covering an area of 2 million hectares with annual production of 2.15 million tones. It has a carbohydrate content of
81.5%, protein 7.3%, crude fiber 4.3% and mineral 2.7% that is comparable to other cereals and millets (Apoorva et al 2010; Ravindran 1991).

Millets have considerable potential for use as an ingredient in foods and beverages. As they are gluten-free they are suitable for celiacs. The major categories of traditional foods where millets can be effectively used are fermented and unfermented flat breads, fermented and unfermented thin and thick porridges, steamed and boiled products, snack foods, alcoholic and nonalcoholic beverages. Cakes, cookies, pasta, a parboiled rice-like product and snack foods have been successfully produced from sorghum and millets (Schober et al 2005).

**Pearl millet** (*Pennisetum typhoideum*), also classified as *P glaucum*, *P americanum*, or *spicatum*, and is locally known as *bajra* in India. (Taylor 2004a). It ranks third after wheat (*Triticum aestivum*) and rice (*Oryza sativa*) (GOI 2008).

Pearl millet is recognized as being the most widely grown of all the millet types. It is the basic staple food in the poorest countries and used by the poorest people. For human consumption it can be used in a variety of ways including both leavened and unleavened breads, in porridges, and can also be boiled or steamed. It is also used as an ingredient in alcoholic beverages. Apart from grain, its stems are used as building materials and as a fuel. It is also widely used in poultry farming and egg production. More recently it has found its way into the pet market, and the most profitable current market where it’s used as an ingredient in bird seed mixes.

Nutritionally, pearl millet makes an important contribution to human diet due to high levels of calcium, iron, zinc, lipids and high quality proteins. Pearl millet contains about 9 to 13% protein, which is higher than in rice (7.2%) barley (11.5%),
maize (11.1%) and sorghum (10.4%) (Desikachar, 1975). Pearl millet contains up to 8% fat which is more than that in wheat, rice, barley and sorghum (Lai et al 1980).

The ash content of pearl millet ranges from 1.6 to 3.6% (Serna et al 1995). Besides, it is also a rich source of dietary fiber and micro nutrients. Starch is the major constituent of pearl millet (Anu Sehgal et al 2006; Malik et al 2002). Minerals especially calcium, iron and phosphorus content of pearl millet is similar to cereals (Adeola et al 1995). Pearl millet is an important source of thiamin, niacin and riboflavin (Taylor 2004). Because of its high oil content, pearl millet is a good source of fat – soluble vitamin E (2mg/100g). Pearl millet contains vitamin A typically about 24 Retinol Equivalents (Taylor 2004). These lipid soluble vitamins are mainly located in germ. As a food source it is non-glutinous and non-acid forming, so is soothing and easy to digest.

Nevertheless, the utilization of millets is limited due to the presence of various anti-nutrients. Pearl millet is often rich in fibre - associated antinutrients namely phytate, oxalate and tannins which have a negative influence on the bioavailability of minerals, also causing poor digestibility of proteins and carbohydrates (Taylor 2004). Due to the presence of the fibrous seed coat, the flour of pearl millet is coarse and has a grey to yellow colour which imparts bitter taste and the products prepared from whole flour have low consumer appeal (Olatungi et al 1982). This is one reason for its poor acceptability by rice/wheat eaters.

Pearl millet is used in many different ways for instance, it can be consumed raw after soaking and sprouting in form of salads but most of them require cooking to improve digestibility, palatability, and keeping quality. In India it is used to make roti which is a thin, flat cake, while in Africa its use is diverse and ranges from baby food
to bread. Processing has significantly altered the physicochemical composition of food grains thereby its nutritional value. Boiling of pearl millet reduced calcium, magnesium and iron concentrations as well as phytate phosphorus (Sushma et al 2008). While roasting improved iron and zinc content, it also decreased the levels of calcium and copper (Malik 2002). Combination of dehulling and cooking of pearl millet resulted in low protein digestibility (Adam et al 2009; Malik 2002; Siddharaju et al 2002). Germination is another common household technique which reduced antinutrients thereby improving nutritional and functional properties of pearl millet and also the mousy odour of damp millet is eliminated (Gupta et al 1991). Germinating pearl millet for 72 hours increased extractability of minerals which represents mineral bioavailability (Badau et al 2005; Arora et al 2003).

Extensive information is available on pearl millet grown in various agricultural institutes under controlled conditions (Archana et al 1998, Pawar et al 1990; Badau et al 2005; Arora et al 2003). However, studies on commercially/locally available pearl millet are lacking. Commercially available pearl millet has a lower shelf life compared to those procured from various agricultural institutions. One of the reasons for this reduction in the shelf life could be longer periods of storing due to transportation and some amount of processing before they reach the market. In the absence of any data on the nutritional composition, functionality and utilization of commercial pearl millet (Pennisetum typhoideum) varieties, the following objectives were formulated.

- To study the physico-chemical properties, nutrient composition, antinutrient and protein profile of raw and processed pearl millet
• To isolate starch from the two pearl millet varieties and study the nutritional and functional characteristics of starch

• To study the antioxidant components and activity of processed pearl millet

• To study the effect of processing on nutrient bioaccessibility (*in-vitro*) of pearl millet (iron and calcium bioaccessibility, nutritionally important starch fractions, and protein digestibility)

• To utilize pearl millet in food product preparation.