Introduction

Underutilized cereals are commonly applied to refer to species whose potential has not been fully realized and are under-researched. India is the largest producer of different kinds of underutilized grains like millets which are often referred to as coarse cereals. However, their consumption is poor due to lack of ready-to-use products similar to rice and wheat, lack of awareness and research based studies on their nutritional quality & health benefits.

Millet is mostly used as whole flour for traditional food preparations and hence confined to traditional consumers and to people of lower economic strata. They are considered underutilized cereal i.e. whose potential is not fully exploited. Over the past 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' have registered to decline from 38.83 Mha. (1949-50) to 29.03 Mha. (2004-05) in terms of total area under production. The total food grain production in India in the year 2008-2009 was 264.38 million tonnes out of which coarse cereal contributed 42.68 million tons (mt) (Agricultural statistics Division, 2014).

Underutilized cereals are the recognized source of dietary fiber, resistant starch, total polyphenol and antioxidant substances. Therefore, realizing the health benefits of these underutilized cereals; industries are now exploring millets for product development. Hence specific design of foods and new products which are acceptable to the population of the region and group specific can help in promoting the millet consumption (Verma and Patel; 2013). Since these underutilized crops/cereals have not been explored for their processed product and value addition, the consumption of these crops have been reduced over the year and with the result it has brought down the production area of these crops and discouraged the farmer for growing these crops. Presently the availability of these cereals has reduced and even if available its prices are very high. In India overall production of millets has increased over the past few decades, from 7.7 Mil tons in 1961 to 10.7 in 2012, but the area dedicated to minor millets has fallen. Finger millet declined from 2.3 million ha in 1951-1955 to 1.35 million ha in 2006-2010 while minor millets declined even more precipitously, from 5.29 million ha to 0.97 million ha over the same period. This has also reduced the diet diversity and crop diversity. Production is inefficient as a result of the lack of suitable higher-yielding varieties, poor quality seed and unimproved cultivation practices. In
addition there is a lack of attractive recipes for value addition, awareness of the nutritional value of millets and favorable environmental policy to promote millets (Padulosi et al., 2015). The unique strength of these underutilized and neglected crops is their rich and favourable nutritional composition, nutraceutical value for product development; which offers uncommon opportunities for income generation to the farmers, in particular the farm women. These crops and their genetic resources, which are being threatened by their status of neglect, have promising potential in the era of climate change in view of their unique adaptive strength. Time has come to review and reassess the importance of these crops in the future agriculture of India and elsewhere in the world. With an increasing population and increasing demands for food, feed, and fuel, society will be pressed to increase agricultural production whether by increasing yields on already cultivated lands or by cultivating currently natural areas or to change current crop consumption patterns (Licker et al., 2010).

Consumption of a single cereal may cause deficiency diseases because of the lower concentration of essential amino acid, minerals and vitamin (Bouis et al., 2009; Sangeeta; 2012). Therefore value addition of millet grains is another strategic approach followed to enhance economic competiveness of these crops. Nutritive value and potential health benefits of millet grains were found comparable to major cereals such as wheat, rice, and maize though utilization of millet grain processing technologies such as fermentation, soaking/malting, and fortification/supplementation to improve the nutritional characteristics of millet grain is limited and is still mainly limited to populations in rural areas at the household level. This is due to lack of innovative millet processing technologies to provide easy-to-handle, ready-to-cook or ready-to-eat safe products and meals at a commercial scale that can be used to feed large populations in urban areas (Ushakumari et al., 2004). Moreover, diversification of food production must be encouraged both at national and household levels in tandem with increasing yields. Providing more healthful and traditional whole-grain and multigrain substitutes in place of refined carbohydrates can be one important aspect of millets therapeutic dietary modification and promoting utilization of minor-grain foods (Singh and Raghuvanshi 2012).

Wheat is a staple food in India and across the world. The gluten is a protein complex found in the triticeae tribe of wheat, barley (Hordeum vulgare)
and rye (Secale cereale), which provides desirable organoleptic properties (texture and taste) to many bakery and other food products (Rai et al., 2011). Gluten protein is well known for producing easy-to-handle, high-quality bakery products and some other grain foods that require elastic and extensible dough. However, since millet grains are gluten-free they seem unsuitable to be converted into pure-millet bakery and some other easy-to-handle solid food products. Thus, use of millet grains as replacement in wheat composite flours, complementary food and food blends seems the best method that can be used for the preparation of nutritional, healthy and safe, high-quality and shelf-stable food products at household and commercial scales to promote utilization of millet grains. In addition the demands for millet and gluten free high quality cereal products have increased at commercial scale due to increased number of people suffering from celiac diseases. In this challenging market, oat, sorghum, and millet have gained a special position (Angioloni and Collar 2012a). Celiac disease is an immune-mediated enteropathy triggered by the ingestion of gluten and characterized by damage of small intestinal mucosa caused by gliadin fraction of wheat (Murry 1999; Fasano and Catassi 2001; Farrell and Kelly 2002; Rai et al., 2011) in genetically susceptible individuals. It is one of the most common lifelong disorders worldwide. In the developed countries, there is a growing demand for gluten-free foods and beverages from people with celiac disease and other intolerances to wheat, barley, or rye. Since millets are gluten-free, they have considerable potential in foods and beverages market that can be suitable for individuals suffering from celiac disease (Taylor et al., 2006; Taylor and Emmambux 2008; Chandrasekara and Shahidi 2011b, 2011c). Since snacks are generally made from corn, wheat, rice and oats are widely available in market while other gluten free cereals have not been used extensively so far (Balasubramanian et al., 2012). This has given birth to a new market consisting of cereal products made from grains other than wheat and rye.

Millets must also be accepted as functional food and nutraceuticals because they provide dietary fibers, proteins, energy, minerals, vitamins and antioxidants required for human health. Several potential health benefits such as preventing cancer and cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, reducing cholesterol and rate of fat absorption, delaying gastric emptying and supplying gastrointestinal bulk were reported for millets (Truswell 2002; Gupta et al., 2012). Therefore, millet grains
have the potential in cancer prevention and for producing food products for celiac people.

The use of novel technology and its optimization like puffing conditions, popping technique can be used as a strategy or in combination with other pretreatments to produce ready-to-eat expands from millet grains at the commercial scale, thus promoting utilization of millet grains. Generally, whole matured dry cereal grains have the ability to be stored for a long time at ambient conditions. However, their milling fractions such as flour and the final prepared food products need some treatments or convenient conditions to improve shelf-life stability because of the impact of moisture and enzymes. Thermal processing is the most extensively used method in food preservation to destroy microorganisms thereby extending shelflife. Therefore processing of millet grains, their fractions and food products must be optimized to protect their quality and potential health benefits.

Millet grains are now receiving specific attention from developing countries in terms of utilization as food as well as from some developed countries in terms of its good potential in the manufacturing of bioethanol and biofilms (Li et al., 2008). The general acceptability of millet based foods was seen as an opportunity to promote more nutritious snacks to urban populations at the same time as enhancing incomes and driving empowerment among millet farmers, thus adding to the role of millets in rural families (Padulosi et al., 2015).

Millets are nutritionally superior to cereals and provide balanced nutrients, yet their utilization in the country is not widespread, millets have hard seed coat and are resistant to insect infestation, this may be due to polyphenols and antioxidants present in the seed coat which make them resistant (Devi et al., 2011). These, dietary polyphenols have received tremendous attention among nutritionists, food scientists, and consumers due to their roles in human health (Tsao 2010; Chandrasekara and Shahidi 2010). Data are needed regarding the effect of processing on physicochemical and phytochemical properties in small grain cereals, as this could lead to new opportunities in commercial production of ready to eat value-added nutraceuticals and other functional foods.

Over the past few decades millets like oat and barley have been commercially exploited. However, the cereals selected for the study kodo millet (*Paspalum scrobiculatum*), finger millet (*Eleusine coracana*), barnyard millet
(Echinocloa frumentacea) and red rice (oryza nivara) may now grab the attention for studying its nutritional properties. Barnyard millet, kodo millet and finger millet are categorized as minor millet (Mishra and Yadav; 2014) whereas red rice is a pigmented rice having phenolic compounds that possess antioxidant, anticarcinogenic, antiallergic, anti-inflammatory, antiatherosclerosis and hypoglycaemic activities (Deng et al.,2013). Barnyard millet, kodo millet and red rice are underutilized cereals grown in Madhya Pradesh, Maharasstra, Uttar Pradesh and have received far less research and development than other crop with regard to utilization. Since these underutilized cereals are the recognized sources of micro- nutrient, dietary fiber, resistant starch, total polyphenol and antioxidant substances. In view of higher nutritional value there is a need for standardization of processing of underutilized cereals to enhance its antioxidant activity, decrease anti-nutritional factors & enhance bio-availability of micronutrients and its utilization for value addition. Therefore, considering these requirements, the present study was undertaken with following objectives

**Objectives**

1. Evaluation of physicochemical characteristics and nutritional composition of selected underutilized cereals.

2. Analysis of antioxidant potential of selected underutilized cereals.

3. Effect of various processing methods on the physicochemical properties and functional component of selected underutilized cereals.

4. Evaluating/testing the suitability of selected grain for the development of value added product/s.