Traditional sources of proteins including animal were considered superior both nutritionally and functionally; however, utilizing animals as source of proteins raised many ethical issues. Moreover, it cannot be continued to be used as a sole source of protein to meet the growing need for proteins due to increasing population. Therefore, interest in finding new protein sources have led to utilization of pulses owing to their high protein content when compared to cereal grains. Pulse proteins are considered to be of higher nutritional quality (Adams et al. 2004; Dogan et al. 2005). Horse gram and lentil are among the most important food legumes grown and consumed in India. In addition to proteins, horse gram is a rich source of iron and molybdenum. Horse gram and lentil are consumed as whole seeds or sprouts by a large population in rural areas of southern India. Lentil and horse gram are source of protein, important minerals and B-complex vitamins. Lentils are rich in dietary fibre, manage blood-sugar disorders, low calories, have virtually no fat and reduce chances of many heart diseases. Horse gram shows antioxidant, astringent and diuretic action. It has been found to be especially useful in the treatment of hemorrhoids, diarrhea, leucorrhea, hemorrhage bleeding during pregnancy, hypertension and kidney and gall stones (Prasad and Singh 2014). Lentil is the most widely used and studied legume. On the other hand, horse gram is under-exploited legume grown extensively in India, mainly for animal feed.

Globulins are the major storage proteins in pulse seeds constituting 35-72% of total protein and the remaining protein fraction mainly consists of albumins. Albumins usually have physiological role (Machuca 2000). Due to disulfide bonds and hydrophobic interactions, globulins have highly packed rigid structure (Utsumi 1992). Among the four major classes of protein in pulses, albumins are unique due to their soluble nature in water (Bean and Lookhart 2001). Owing to this solubility, albumins are capable of interacting and competing with starch for water more efficiently. Poor digestibility of these pulse proteins is the major nutritional constraint in their use. Digestibility can be used as measure to determine susceptibility of a protein to proteolysis and an indicator of protein availability. Highly digestible proteins are more
desirable as they would provide more amino acids for absorption on proteolysis and are therefore of better nutritional value than proteins of low digestibility. Functional properties, such as foaming properties, water and oil absorption capacities, emulsification and solubility determine the suitability of proteins to be used as hydrocolloids in food formulations (Kinsella and Phillips 1989).

Determination of processing and storage conditions of proteins is possible only with the knowledge of their functional properties. Functionality and interaction of different food constituents influence each other and are interdependent. Functional properties of food constituents determine type of interactions and these interactions influence functional properties of food products (Tang et al. 2011b). Functional properties of proteins and its physiochemical and structural properties are directly related. Albumins are very diverse structurally and functionally. Polypeptide chains constitute protein subunits, two or more subunits join to form oligomers which are typically seed storage proteins (Ward et al. 1994). The knowledge on interaction of food ingredients is important for understanding their functionalities in real food systems as these interactions influences properties of food products (Zhang and Hamaker 2003). Interaction of protein with starch significantly influences the pasting and textural properties of starch and determines properties of food products such as flow, stability functionality, structure, texture and mouth feel of food products (Li et al. 2007; Chinma et al. 2013).

Proteins and polysaccharides are being used widely to improve food texture or functional properties in various food formulations. Recent studies suggest that interaction of maize starch with soybean protein influence various starch properties such as pasting, thermal, retrogradation, rheological and microstructure properties of starch gel (Li and Yeh 2003; Zhang and Hamaker 2003). The stability of food dispersions are also significantly influenced by protein-starch interactions in bulk solutions and at interfaces. Electrostatic interaction between the positively charged groups of the protein and the anionic groups of the starch can exhibit one of the three different equilibrium situations: miscibility, thermodynamic incompatibility and complexation (de Kruif and Tuinier 2001; Martinez et al. 2005). Many studies consisting starch and wheat gluten proteins as model systems have been conducted, while similar systems on pulse proteins have not been evaluated. Associations between
gluten proteins have been reported to be electrostatic in nature and pH and concentration dependent (Eliasson and Tjerneld 1990; Eliasson 1993). The interactions occurring at neutral pH have been attributed to the hydrophobic nature of gluten proteins. The surface proteins were reported to be basically involved in gluten-starch interaction (Lindahl and Eliasson 1986). Proteins from horse gram and lentil have been studied for their composition and effect of germination on their functional properties. Some studies suggest that proteins in the starch granule obstruct the access of amylolytic enzymes.

Although pulses are valuable source of good quality proteins, vitamins, dietary fibers and minerals, there are few limitations in utilization of pulses due to the presence of certain antinutritional factors and hemagglutinins (Alonso et al. 1998). Phytates, polyphenols, enzyme inhibitors present in pulses are considered as constraints in effective utilization of pulses. Different processing techniques including autoclaving, fermentation, radiation, dehulling, cooking, boiling, roasting, soaking, germination, extrusion etc have been employed in order to increase utilization of pulses. However, most of these treatments are not readily adaptable because of reasons including requirements for large equipment, high operational costs involved, etc.

Thermal processing improves texture and palatability of pulses as well as inactivates heat labile compounds and enzyme inhibitors (Sreerama et al. 2008). Manipulation of processing conditions in an effective manner may be required to remove unwanted components. Because of its advantages over other treatments extrusion is becoming popular as a processing technique. Extrusion parameters can be easily manipulated to improve product quality and acceptability. Extrusion is a high-temperature-short-time (HTST) treatment during which flours or starches are subjected to high mechanical shearing at relatively low moisture levels (Camire et al. 1990). Raw material and extrusion parameters affect the quality attributes of the final product. Protein concentration, moisture level and physical and mechanical parameters of the extruder significantly affect the physical and sensory qualities of extrudates (Day et al. 2013). Extrusion promotes cross-linking among different flour constituents. Polymerization occurs among proteins and starches resulting in the formation of expanded matrices due to shear, heat and pressure (Li and Lee 1997). These interactions alter protein structure,
solubility and digestibility. Functional properties of extrudates such as expansion index, solubility indices etc determine its texture and sensory characteristics (Oikonomou and Krokida 2011). These functional properties are affected by extrusion parameters such as moisture content and particle size and extruder attributes such as barrel temperature and screw speed, etc. Pre-cooked flour obtained by extrusion cooking has gelatinized starchy component and can be used as baby foods. The particle size of the flour, the moisture content and extrusion conditions are important factors influencing the properties of extruded baby foods (Mian et al. 2007).

Another processing technique widely adopted to improve quality and increase utilization of pulses is germination. Pulse sprouts are commonly used in human diets throughout the world and special emphasis has been given to pulse sprouts as new source of functional foods. Germinated pulses and legumes have been identified as potential source of nutritious food and are becoming popular as food ingredients (Shah et al. 2011). Germinated flours have numerous applications in food industries. Flours from germinated pea, lentil and faba bean have proved to be better than that from raw seeds nutritionally and have been utilized in production of many food items including bread and pasta (Torres et al. 2007). Incorporation of germinated lupin flour improves nutritional profile of foods as result of increase in fibre and decrease in fat content with germination (Rumiyati et al. 2012). Production of bioactive peptides is enhanced during germination. Pulses contain storage proteins, proteolytic enzymes and hydrolases that are localized called protein bodies (Tiwari and Singh 2012; Graham and Gunning 1970). During germination these protein bodies enlarge and the proteolytic activity of pulses also increases (Bewley and Black 1978). Germination of seeds transports reserves from the seed to the growing seedling causing changes in concentration of macromolecules and activities of different metabolites. Activation of many enzyme systems in the germinating seeds is usually accompanied production of new compounds (Wanasundara et al. 1999).

Germination decreases antinutrients and increase digestibility of proteins. Germinated wheat shoots are known as wheatgrass. Wheatgrass is freshly juiced and/or dried into powder for animal and human consumption. It is also known as nature’s finest medicine and is increasingly getting popular after being widely accepted in the west. Schnabel
Introduction

studied various aspects of cereal grasses related to nutrition and growth and found that high quality cereal grasses were obtained in specific soils and their nutritional profile varied with the stage of growth of the grasses. Wheatgrass juice (WGJ) is believed to possess maximum therapeutic qualities when extracted fresh and it is recommended that it should be consumed within an hour of extraction. The therapeutic benefits of wheatgrass are numerous; it is therefore, becoming extremely popular as nutraceutical. WGJ is a good source of minerals (potassium, magnesium and calcium), vitamins (vitamin C and E), enzymes (superoxide dismutase, catalase), amino acids, bioflavonoids, phenolic compounds (ferulic acid and vanillic acid) etc (Walters 1992). Increase in vitamins, ferulic acid and vanillic acid content with increase in germination period results in increase in antioxidant potential (Day et al. 2006). Wheatgrass acts as a de-toxificant, stimulates metabolism, reduces acidity of the blood and restores alkalinity.

Chlorophyll is the major component of wheatgrass and responsible for inhibiting the metabolic activation of carcinogens (Lai et al. 1978; Lai 1979). Chlorophyll is easily absorbed in blood and boosts red blood cell formation and prevents anaemia. WGJ has been reported to decrease requirement of medications for blood and bone marrow building during chemotherapy in breast cancer patients who took WGJ (Bar Sela et al. 2007). WGJ reduced the side effects of chemotherapy without affecting the efficiency of chemotherapy. Wheatgrass extracts also contain significant amounts of phytochemicals and bioactive compounds including phenolic and flavonoids (Calzuola 2004). Phenolic compounds in plant products mainly contribute to their antioxidant activity which reverse the effect of ROS mechanism by various pathways, and also reduce incidence of cancer. Falcioni and co-workers have demonstrated the inhibition effect of wheatgrass on oxidative DNA damage (Falcioni et al. 2002; Blokhina et al. 2003). Hussain et al. (2014) reported that wheatgrass exhibits tumoricidal effects. It induces apoptosis and cell cycle arrest and acts as a biological response modifier in cancer treatment. WGJ has also been shown to be protective against chronic diseases such as diabetes and cardiovascular disease and many skin diseases (Jacobs et al. 1998; Meyer 2000). It was reported that inclusion of wheatgrass in diet resulted in a significant decrease in glycemic index. It was also shown that thalassaemia patients
who took WGJ required less blood transfusion as compared to patients who did not take WGJ (Marwaha et al. 2004). However, one major problem with wheatgrass is its gluten protein which cannot be consumed by patients with gluten allergy also known as celiac disease. In such cases possible substitute can be pulses. Pulse sprouts have great nutritional properties and are widely consumed.

Many studies on nutritional improvement due to germination have been carried out but effect of germination on proteins has not been extensively explained. Although starches and proteins form horse gram and lentils have been extensively studied separately, literature on the interaction between their protein and starch is scanty. Literature on shoots of germinated pulses and wheatgrass composition is limited.

Thus, keeping in view all the above said considerations, the research work was planned to achieve the following objectives:

1. To characterize lentil and horse gram for protein diversity through biochemical markers and secondary structure.
2. To evaluate diversity in amino acid and mineral composition of lentil and horse gram.
3. To evaluate protein fractions for functional properties and in vitro digestibility.
4. To evaluate interaction of different fractions of proteins with major and minor constituents and study their effect on in vitro protein digestibility.
5. To study the effect of processing conditions on protein properties and in vitro protein digestibility.
6. To study effect of germination on protein profile and functional properties.
7. To compare chemical and nutritional properties of germinated pulse shoots with wheat shoots.