ABSTRACT

Amaranth, which belongs to genus Amaranthus, is widely distributed, short-lived herbs, occurring in temperate and tropical regions. The genus Amaranthus consists of approximately 60 species and among them *A. hypochondriacus*, *A. cruentus* and *A. caudatus* are the main grain producing species. Amaranth grains are rich in protein with a high content of essential amino acids (it has many bioactive compounds with health-promoting effects such as phytosterols, polyphenols, saponins, and squalene) and are considered suitable for diets of celiac disease patients due to its gluten-free nature.

The amaranth grains contain some antinutritional factors e.g. tannins, trypsin inhibitors and phytates. Germination is one of the most common processes for improving the nutritional quality of grains and helps in reduction of anti-nutritive factors. The inclusion of germinated grains in the product formulation may improve nutritional quality, increased digestibility and bioavailability of some nutrients and reduction of some antinutrients. Amaranth grains also shows many health benefits, such as decreasing plasma cholesterol levels, stimulating the immune system, antitumor activity, reducing blood glucose levels and improving conditions of hypertension and anemia

Hence, the present study was undertaken to characterize the raw and germinated amaranth grains flour to develop food products like cookies and pasta and also to evaluate their quality and nutritional value. The present work has been compiled into five chapters. The Chapter one deals with introduction part, in which different aspects of amaranth has been discussed. The 2nd chapter begins with the literature review on the composition of amaranth grains and effect of germination on amaranth grain composition. Utilization of amaranth flour in different food products and its nutritional evaluation have also been discussed in this chapter. Materials and methods used to fulfill the objectives of research
work are presented with details in the 3rd chapter. The variety VL - 44 of *Amaranthus hypochondricus* have been procured from Vivekanand Pravatiya Krishi Anushandhan Sansthan (VPKAS), Almora, Uttrakhand, India. It included methodology of germination, proximate composition, physico-chemical properties, mineral composition, anti-nutritional factors, functional components, fatty acid profile and amino acid profile. This chapter also covers the methodology of cookies and pasta preparation from raw and germinated amaranth flour. The methodologies about products quality and nutritional evaluation and storage study have also been discussed in this chapter.

The fourth chapter included results and discussion related to optimization of germination process and processing parameter of amaranth grain (raw and germinated), preparation of flours and their characterization, product (cookies and pasta) preparation, products evaluations and storage study. The fourth chapter is further divided in five sections. The first section covers optimization of germination process and effect of the processing parameter of amaranth grain (raw and germinated) to prepare flour. The optimal conditions for germination of amaranth grain were germination time (22 h) and germination temperature (35.86°C). Under these optimal conditions, amaranth grain showed higher nutritional and lower antinutritional factors. The process for the preparation of flour from raw and germinated amaranth grains was optimized by using two mills viz. stone mill and cyclotech mill at different moisture content (10, 12, 14, and 16%). The produced flours were analyzed for the average particle size and functional properties. Among both mills, cyclotech mill produces a finer particle size of raw and germinated amaranth flour. Among different moisture content, 12% moisture content was optimized for optimum particle size and improved functional properties.

In the second section, the characterization viz. proximate composition, color analysis, functional components, mineral content, fatty acid profile, amino acid profile,
morphology, pasting profile, and antinutritional factors of optimized raw and germinated amaranth grain flour have been discussed. Germinated amaranth flour shows significantly (p≤0.05) higher ash, protein, crude fibre, reducing and total sugars than raw amaranth flour while the significantly lower value for fat, carbohydrate, and starch content than raw amaranth flour. Germinated amaranth flour resulted in lower L* (77.85) as compared to the raw amaranth flour (80.20), which indicates the darker color of germinated amaranth flour. The results of functional components revealed that germinated amaranth flour exhibited significant (p ≤ 0.05) higher value for antioxidant activity, total dietary fibre, total phenol content, and total flavanoid content than raw amaranth flour. Minerals viz. Calcium, magnesium, sodium, iron, potassium, and zinc were analyzed. All mineral content increased significantly after germination except iron. Calcium, sodium and potassium are the predominating minerals and after germination maximum increase was noticed in potassium. The results of fatty acid profile showed that linoleic was the dominant fatty acid, while palmitic acid was found as minor fatty acid in amaranth flour. The eighteen amino acids were identified and quantified by HPLC. The maximum increase was noticed in Histidine, which was 1840 mg/100 g after germination, while in raw amaranth it was 280 mg/100 g. The Scanning electron micrograph indicates raw amaranth starch granules exhibits polygonal character. The results of pasting profile revealed that germination significantly reduces the pasting properties of amaranth flour. Germinated amaranth flour exhibited lower values for antinutritional factors viz. Phytic acid and tannin, than raw amaranth flour.

In the third section, cookies and pasta were prepared from raw and germinated amaranth grain flour and analyzed for various quality characteristics. As per the texture results, germinated amaranth flour cookies was softer than raw amaranth flour cookies and control cookies. Sensory analysis revealed that germinated amaranth flour cookies shows
the highest score for all sensory attributes than raw amaranth flour cookies and wheat flour cookies. Pasta prepared from raw and germinated amaranth flour with the addition of different hydrocolloids (guar gum, gum acacia and gum tragacanth) at 0.5 and 1.0% level. Among the all pasta samples, pasta prepared with 1.0% guar gum showed improved cooking, textural, and sensory characteristics. In addition, raw amaranth flour pasta preferred over germinated amaranth flour pasta samples in terms of superior cooking, textural, and sensory characteristics. In the fourth section, storage study showed that all the quality parameters of raw and germinated amaranth flour cookies were within the permissible limits up to 90 days storage period. Likewise, raw and germinated amaranth flour pasta could be stored up to 180 days at ambient condition without changing their quality characteristics. In the fifth section, nutritional evaluations of cookies and pasta have been discussed. Results showed that germinated amaranth flour cookies and pasta represents higher nutritional value than raw amaranth flour as well as control cookies and pasta.

Based on above findings, the results have been summarized and conclusions have been drawn in fifth chapter. Results suggested that the raw as well as germinated amaranth flour represent great nutritional profile for manufacture of nutrient-rich gluten-free products. Furthermore, our results indicate considerable variations in chemical composition of the amaranth flour by germination. Studies shows that germinated amaranth flour cookies were more acceptable than raw amaranth flour cookies. While raw amaranth flour was more suitable for pasta preparation than germinated amaranth flour. Results of nutritional evaluation showed that germinated amaranth flour cookies and pasta represents higher nutritional value than raw amaranth flour as well as control cookies and pasta. Storage study data revealed 90 days safe storage for cookies and 180 days storage for pasta prepared from raw and germinated amaranth flour.