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Effect of Germination on Proximate Composition of Amaranth Seeds (*Amaranth Cruentus*)

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Abstract

Effects on proximate composition of amaranth during germination were studied. Amaranth grains were geminated during 48 hours at ambient condition was subjected to proximate analysis. Germination of amaranth for 48 hours had a significant effect on nutritional factors. On proximate composition, protein content and carbohydrate content were found to be increased from 18.13 to 20.53% and 54.2 to 55.5% respectively but not increased significantly whereas Similarly crude fat, crude fiber & total ash significantly decreased from 9.66 to 7.07%, 4.01 to 3.96%, and 54.5 to 55.5% respectively on dry basis.

Keywords: Amaranth, Germination, Proximate Constituent

Introduction

Amaranth (family Amaranthaceae) is an underexploited plant with an exceptional nutritive value. Amaranths are broad-leafed non-grass plants that are easy to grow, nutrient rich and an underutilized pseudo cereal that can play an important role in actions against hunger and malnutrition. It is either consumed as a leafy vegetable or as grain. The grain amaranth is very versatile as a food ingredient and can diversify farming enterprise; as it can be used to prevent food depletion and to feed the world (Saunders & Beckar, 1983).

Amaranth has been touted as a miracle grain, a super grain, and the grain of the future (Samuel, 1991). The seeds contain large amounts of dietary fiber, iron, and calcium. The crude protein content of grain amaranth ranges from 11 to 17.6 % dry matter (Bressani, 1989). This is higher than in most common grains except soybeans. The protein quality of grain amaranth is complete containing around 5% lysine and 4% Sulphur amino acids, which are the limiting amino acids in other grains. The lysine content is given as the main reason for the high protein quality of amaranth (Saunders & Beckar, 1983). Amaranth complete protein also contains significantly more Sulphur amino acids than soya complete protein. The amino acid composition of amaranth protein compares well with the FAD/WHO protein standard for instance lysine in amaranth is 6.233g/100g while the standard 5.4g/100g. In addition to its outstanding nutritional value, amaranth is also very low in sodium and contains low saturated fat (Kariuki *et al.,* 2013). Nowadays, three amaranth species are mainly used for seed production; these are *Amaranthuscruentus L., A. caudatus L., and A. hypochondriacus L.* Amaranth grains can be roasted, popped, while whole grains can be boiled and mixed with various foods like rice, steamed vegetables and other dishes to boost nutrient level. The proximate compositions of cereals and pseudo-cereals are given below:

Table Comparison of proximate composition of different cereals and pseudo cereals

Composition	Amaranth	Wheat	Corn	Rice
Carbohydrate	59.2	66.9	67.7	75.4
Crude Protein	16.6	14.0	10.3	8.5
Fat	7.5	2.1	4.5	2.1
Crude fibre	4.1	2.6	2.3	0.9
Ash	3.3	1.9	1.4	1.4
Moisture	9.6	12.5	13.8	11.7

Source: *Cai, Corke, and WU (2004)*

Germination is the process in which a plant or fungus emerges from a seed or spore, respectively, and begins growth. It is the beginning of the development of seed embryo in which viable seed is wetted: water is taken up, respiration, protein synthesis and other metabolic activities begin and after a certain period of time, the radicals or hypocotyls emerges through the seed coverings which mark the end of the process. Germination is such process employed to improve the nutrient composition and functional properties of legumes and cereal seeds (Shrestha, 2012).

Germination is controlled by several different factors, with the most important being the supply of oxygen, removal of carbon dioxide and elimination of heat formed by respiration. Germination is usually performed at 16-20 °C (Bamforth, 2000). At a higher temperature the grains germinate faster and thus produce enzymes at an earlier stage. However, the rate of the formation of enzymes is stopped after some time, thus in the end grains germinated at lower temperatures contain higher levels of enzyme than grains germinated at higher temperatures (Palmer, 1989). Long cool germination cycles maximize fermentability and minimize malting losses. During germination, moisture is transferred from the malt to the surrounding air. To sustain its growth, the embryo withdraws moisture from the starchy endosperm, causing a progressive drying (0.5% per day) of the endosperm. This is helped by spraying with water to retain the moisture content. About 4% of the initial barley dry matter is lost to embryo respiration (Bhatty, 1993).

Materials and Methods

Materials: Amaranth (*Amaranth cruentus*) was collected from Doti district of western Nepal (local product) where the grains were ready which were selected randomly, carefully sorted and dry in the sun then stored at room temperature. Then the seeds were first winnowed with woven bamboo trays (*nanglo*). In this step, husk immature grains and light particles were winnowes away and heavier particles such as pecks and stones were separated by gravity during winnowing. The cleaned seeds were transferred to the stainless vessel and then disinfected with 70% ethylalcohol and 3% $CaCl_2$ for 5 min. Then they were washed thoroughly and soaked distilled water (seed-water ratio 1:5 w/v) for 5 hrs at room temperature. Light materials present in the sample were skimmed off. Agitation with stirrer was sone to clean the light seeds. After staining the water, the steeped seeds were spread over a cardbox covered with sterile aluminium foil to keep moisture constant and germinated at a room temperature. Germination was carried out during 0, 24 and 48 hours. The seed were turned and mixed from time to time to equalize the temperature and moisture during germination. Samples were taken at interval of 24 hours. The samples of each day were subjected to drying in a hot air oven at 60ºC to halt the further germination of seeds.

Methods

All the chemical analyses were done on wet basis (wb) and the results were presented on dry basis (db). On proximate composition moisture content, crude protein, crude fat, crude fiber and total ash were analyzed based upon the procedure of “Handbook of Analysis and Quality Control for Fruit and Vegetable Products” by Ranganna (2007) whereas the total carbohydrate were analysed by difference method.

Data analysis: The obtained triplicate data were processed for mean, standard deviation, one-wayANOVA and least significant difference (LSD).

Results and discussion

Changes in moisture content during germination:

The moisture content for raw and germinated amaranth grain at 0h, 24h and 48h was found to be 10.46, 9.49 and 9.98 respectively. The statistical analysis showed that the change in moisture content was change significantly ($p<0.05$) during germination.

Changes in crude protein during germination:

The average protein for raw amaranth was found to be 18.13% (db). During 48 hrs of germination, the protein content of amaranth was found to be increased gradually, i.e 19.51% (db) on 24 hrs and 20.53% (db) on 48 hrs. The stastistical analysis showed that the changes in crude protein were not change significantly ($p>0.05$).Bressani and Colmenares, (1990), reported that the crude protein content in ungerminated amaranth grain was 15.4%. After 5 hours of steeping the crude protein content increased to 16.6%. At $P>0.05$ there were no significant differences in protein content with respect to germination times.

Changes in fat content during germination:

The average total fat content for ungerminated amaranth was 9.66%. Germination of amaranth for a 48 h was found to be decrease in fat content i.e 7.28% on 24 h and 7.01% on 48 h of germination.

The statistical analysis (one way ANOVA) showed that the fat content of amaranth has significantly difference ($P<0.05$) during 48 h of germination. According to Kanensi, Ochola, Gikonyo, and Makokha (2011), the ungerminated amaranth grain had a fat content of 8% dry basis. The fat content was decreased on germination where there is a significant differences ($P \leq 0.05$) in fat content among raw and germinated amaranth flour. This decrease in fat content could be because of increased activities of lipolytic enzymes during germination which hydrolyses fat component into fatty acids and glycerol (Chauhan *et al.,* 2015).

Changes in crude fiber during germination:

The average crude fiber in amaranth grain was found to be 4.01%. Germination of amaranth for 48 h was found to be decrease the crude fiber during 24 h 3.91% and hence slightly increases at 48 h 3.96%. The statstical analysis showed that crude fiber of amaranth has no significant difference (P>0.05) during germination. (Bressani and Colmenares, 1990) reported that the crude fiber content of *Amaranth crutenus* is 2.2% and there was no significant changes (P>0.05) in crude fiber content of amaranth grain with change in germination time.

Changes in total ash during germination:

The average total ash for ungerminated amaranth grain was found to be 3.22%. Germination of amaranth for 48 h, was found to be decrease the total ash content 2.78% on 24 h and slightly increases 2.92% on 48 h.

The statistical analysis showed that the total ash content of amaranth has significant difference (P≤0.05) during 48 hrs of germination.The ash content is almost similar to the amount got by other researchers. The ash content of *amaranth cruentus* was reported as 3.2% on dry weight basis (Berghofer and Schoenlechner, 2009; Souci, *et al.,*2000). (Bressani and Colmenares, 1990) has reported that ash content of ungerminated amaranth grain is 30% and the value do not change with respect to germination time.

Changes in carbohydrate content during germination:

The average carbohydrates content for amaranth was found to be 54.52% before germination. After 24 hour germination it was found to be increase to 57.03% and then slightly decrease to 55.55% on 48 h.The statstical analysis (one way ANOVA) showed that the carbohydrate content of amaranth grain was no significant difference (P>0.05) during germination.

Conclusions

Gradual decrease in moisture was observed. The crude protein were gradually increase during 48 hours but not change significantly whereas the total ash, crude fiber and carbohydrate content also decrease gradually. Vanderstoep (1981) reported that during seed germination, a breakdown of seed reserves, carbohydrates, and some cases protein. Godwin and Mercer (1972) reported that in the germinating seeds, the stored fats are metabolized by lipase enzymes.A Chauhan and Singh (2013) reported that fat content value for 12h and 16 h germinated flour was 6.06% and 5.0%, respectively (table 2), which was significantly (P < 0.05) lower than control or ungerminated flour (6.76%). The fibre content increased significantly (P < 0.05) with increasing germination time, reaching a maximum on the 16 h germination.Germination significantly (P < 0.05) increased the protein content of amaranth flour; the 16 h of germination had the maximum value. Mbithi-mwikya et al. (2000) reported that there was a slight but significant increase in protein content of finger millet during germination. Working with broccoli seeds, Taraseviciene (2009) also found that crude fibre content was increased with increasing germination time. Similar observations of lowered fat content on germination are reported by for broccoli seeds (Taraseviciene, 2009).The decrease in carbohydrates in germinated grains may be attributed to increase in alpha-amylase activity which breaks down complex carbohydrates into simpler and more absorbable sugars. Also the the increases in protein content to be due to dry matter loss particularly through carbohydrates through respiration causing an apparent increase in other nutrients such as proteins.

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