Varietal identification and seed quality estimation through biochemical characterisation in Amaranth (*Amaranthus hypochondriacus* L.)

ABSTRACT

The present investigation was conducted during *kharif* of 2021 College of Forestry, Ranichauri, Tehri Garhwal of VCSG Uttarakhand University of Horticulture & Forestry, Bharsar, Pauri, Garhwal, Uttarakhand, to investigate the biochemical characteristics in different varieties of amaranth.The laboratory experiment was conducted in completely randomized design (CRD) with three replications comprising seven varieties *viz.,* VL-110, Rudrakshya, Durga, PRA-1, PRA-2, PRA-3 and Annapurna to assess the seed quality and biochemical characters of grain amaranth.In laboratory condition, the seed quality attributes (under standard germination test) *viz.,* germination percentage, seedling total length, seedling fresh and dry weight, seedling vigour indices were recorded higher in T5 (PRA-2), under stress test *viz.,* accelerate ageing, cold test and water sensitivity test, the significantly higher value of seed quality parameters were recorded for T6 (PRA-3).On the basis of investigation, it could be concluded that treatments T4 (PRA-1), T5 (PRA-2), T6 (PRA-3) and T7 (Annapurna) showed overall better performance for biochemical and seed quality of amaranth.

Keywords: Amaranth, biochemical, seed quality, accelerate ageing

INTRODUCTION

Amaranth is considered one of the most important leafy vegetables. Amaranth *(Amaranthus spp.)* also referred to as "Chaulai". The genus *Amaranthus* consists of approximately 60 species out of which 18 species are present in India. There are three grain amaranth species namely (*A. hypochondriacus*, *A. caudatus and A. cruentus*) which are self- pollinating diploids having chromosome no. 2n = 32, 2n=34 and 2n= 64. *A.cruentus* L.and *A. hypchondriacus* L. originates from Central America and North America respectively whereas *A. caudatus* L. originates from South America. Amaranth can be grown from temperate to tropical conditions due to its high adaptability and versatility. Besides these species, one of the grain amaranth species is *A. edulis*. Further there are three weedy species i.e. *A. hybridus*, *A. powelli* and *A. quitensis* associated with the crop (Rastogi and Shukla, 2013). It is a crop that grows quickly, has a quick potential yield, and may be rotated with any other vegetable crop. In the last 20 years amaranth has been rediscovered as a promising food crop mainly due to its resistance to heat, drought, diseases and pests, and the high nutritional value of both seeds and leaves (National Research Council 1984, Saunders and Becker, 1984). The composition of amaranth isparticularly favourable in essential amino acids, and its protein quality is much higher than conventional food sources like wheat, barley and maize (Venskutonis and Kraujalis, 2013).

Amaranthus has prominent nutritional value due to the high content to important micronutrients, protein (14-19%), carbohydrates (62-66%), fiber (4-5%), fat (6-7%),(2.5-4.4%) ash (Mlakar *et al.* 2009). Amaranth is mainly grown from tropical low lands to 3500m above mean sea level in the Himalayas (Sauer, 1967). Amaranth proteins are globular proteins which mean that they take a longer time than random-coil proteins (like casein) to unfold and absorb onto the oil/water interface (Kierulf *et al.* 2020). Seed is an essential element in agriculture which decides the success of any crop production programme and the use of good quality of seeds is necessary for the successful production of any crop. Quality testing has a great importance for the evaluation varietal superiority in the environment (Kumar *et al*. 2015 and Manikandan *et al*. 2015). Considering the above facts, the present investigation entitled"Studies on varietal identification through biochemical characteristics and seed quality in Amaranth (*Amaranthus hypochondriacus* L.)" was carried out.

MATERIALS AND METHODS

The lab experiment was conducted at Seed Science lab, College of Forestry, Ranichauri.The laboratory experiment was conducted in Completely Randomized Block Design (CRD) with three replications comprising seven varieties *viz.,* VL-110, Rudrakshya, Durga, PRA-1, PRA-2, PRA-3 and Annapurna to assess the seed quality and biochemical characters of grain amaranth. In laboratory condition, (under standard germination test) *viz.,* germination percentage, seedling total length, seedling fresh and dry weight, seedling vigour indices, protein content and electrical conductivity test were recorded.

RESULT AND DISCUSSION

The statistical analysis showed highly significant differences among the varieties for all the experiment studied. The mean value for all the experiments has been presented in the Tables 1 to table 2. In order to evaluate the ability of seeds to emerge under favourable conditions, a standard germination test was used (ISTA, 2003).According to the findings of the current study, T5 (PRA-2) had a significant effect on the first count and germination percent. Such kind of information presented in wheat (Moshatati *et al*. 2012) and bean seed (Kolasinska *et al*. 2000). Genetic variations among the various varieties may be due to the cause of the variation in first count and germination %. Germination seems to be biological process depending on several factors including the different behaviour of varieties. Similar results also reported by Kumar *et al*. (2015) in amaranth.

A beneficial indicator of seed vigour is the length of the seedlings roots, shoots, and overall length, leading towards better plant establishment. Significantly highest seedling root length, seedling shoot length and total seedling length was recorded in T5 (PRA-2). The length of the seedlings roots and shoots was used to determine its total length. Similar findings were reported by Kumar (2023) in chia seeds and Naseem *et al*. (2007) in buckwheat. Due to differences in the genetic make-up of varieties, variation in seedling root length, seedling shoot length, and overall seedling length of different varieties were also found to be considerable. This could be due to the freshness of seed and genetic potential of the variety. The results were in conformity with Naseem *et al*. (2007) in buckwheat. Maximum seedling growth result in better seedling establishment and higher plant growth and higher yield in field Moshatati *et al*. (2012) in wheat. Significantly highest seedling fresh weight and seedling dry weight was recorded in T5 (PRA-2). It might be because food reserves were used more effectively and quickly, resulting in seedlings with higher fresh weight. These findings agreed with Naseem *et al*. (2007) in buckwheat, Arivazhagen and Kadarmohideen (2006) in French bean and Panwar (2023) in quinoa. Kumar and Panwar (2023) also reported that seedling dry weight might be higher due to change in moisture percentage. The significantly higher seedling vigour index I and seedling vigour index II were recorded in T5 (PRA-2). That might be due to genetic potential of the variety to produce higher seedling root length, seedling shoot length, total seedling length, seedling fresh weight, seedling dry weight and germination percent. These were in consistent with the findings of Krishnappa *et al*. (2001) in finger millet and Panwar (2023) in quinoa seeds.

Electrical conductivity was found to be maximum in T1 (VL-110) which was statistically *at par* with T2 (Rudrakshya) and minimum in T5 (PRA-2). The similar findings were reported by Kumar (2023) in chia seeds. Weak seeds generally possess poorer membrane structure, which results in greater electrolyte loss and higher conductivity measurements Pandey (1992) in sorghum. Lower the amount of leachates released to the soaking solution, indicates high seed vigour and *vice-versa* in soybean (Adriana *et al*. 2012). The difference in electrical conductivity in different amaranth varieties might be due to variability in genetic constitution, moisture content and temperature. Crude protein was found maximumin T1 (VL-110) which was significantly at par T2 (Rudrakshya). Similar findings were reported by Bressani (1994) in amaranth, Gimplinger *et al*. (2007) in amaranth seeds. Seeds with higher seed weight resulted in decreasing crude protein. The grain of amaranth is covered by the seed coat and a poorly developed endosperm. It is known that the germ fraction contributes significant amounts of protein to the whole seed (Bressani, 1994). Increasing seed size predominantly affects the starchy portion of the perisperm as opposed to the germ. Hence, it can have an effect of reducing seed protein (Brenner *et al*. 2000).The protein content of amaranth seems to be negatively correlated with yield like it is in other grain crops (Feil, 1998).

The germination percentage, seedling length, dry weight and vigour index-I and Vigour index-II were significantly influenced by the cold test. The significantly higher germination percentage was recorded in T6 (PRA-3) which was statistically at par with T5 (PRA-2) and higher seedling length was recorded in T6 (PRA-3). Higher seedling dry weight was observed in T6 (PRA-3) which was statistically at par with T4 (PRA-1), T5 (PRA-2) and T7 (Annapurna) and higher seedling vigour index-I and II was recorded in T5 (PRA-2) and T6 (PRA-3).When compared to the standard germination test, the cold test had no adverse effects on seedling dry weight, vigour index-I, and vigour index-II. This might be due to seeds being able to resist conditions of cold stress in amaranth. The current findings were in consistent with the findings of Ilyas *et al*. (2022) in *Brassica napus* and Panwar (2023) in chia seeds. In numerous species, seed ageing has been recognised as the principal cause of decreased germination, vigour and viability. The highest qualities of the seeds were found at physiological maturity after that it starts decreasing with the passes of time/storage. The current study found that amaranth seeds were recorded lower germination, seedling length, fresh weight, dry weight and vigour under the accelerated ageing test when compared with standard germination test. Germination percentage was recorded higher for T6 (PRA-3). The current findings were in consistent with Panwar (2023) in chia seeds, Kapoor *et al*. 2010 in chickpea and Samrah and Al-Kofahi (2008) in barley seeds. Genetic potential of varieties to perform under stress condition and degradation of mitochondrial membrane, leading to reduction in energy supply required for germination (Gidrol *et al*. 1998).

Germination percentage, seedling length, dry weight, vigour index-I and vigour index-II increased in low moisture condition than in high moisture condition under water sensitivity test. That might be due to the ability of Amaranth plants to grow better under less moisture condition. The highest germination percentage was recorded in T6 (PRA-3) which was statistically at par with T3 (Durga), T4 (PRA-1), T5 (PRA-2) and T7 (Annapurna). The higher seedling length and dry weight was recorded in T6 (PRA-3) which was statistically at par with T5 (PRA-2) and T7 (Annapurna) and vigour index-I and vigour index- II were observed in T6 (PRA-3) which was statistically at par with T4 (PRA-1), T5 (PRA-2) and T7 (Annapurna). The ability of amaranth to germinate under low moisture stress and the positive association ship between seedling fresh weight, dry weight, and genetic variation among the varieties might also contribute to this. The above results are in conformity with the study of Yamuna Devi G (2022) in quinoa, Panwar (2023) in chia seeds and Tzortzakis (2009) in grain amaranth.

CONCLUSION

Based on the experimental findings, it could be concluded that T4 (PRA-1), T5 (PRA-2), T6 (PRA-3) and T7 (Annapurna) overall better performance for seed quality and biochemical characters. For the highest yield and good quality, the genotypes PRA1, PRA2, PRA 3 and Annapurna recommended in hills of Uttarakhand for the cultivation.

Table 1: Mean performance for different varieties of amaranth on seed quality for standard germination

Treatment	STANDARD GERMINATION								
	First Count	Seedling shoot length (cm)	Seedling root length (cm)	Seedling length (cm)	Fresh wt. of seedling (mg)	Dry wt. of seedling (mg)	Germination %	Vigour Index-1	Vigour Index-2
T_1: VL-110	10.67	2.09	1.31	3.40	31.67	16.67	74.67	253.99	1245.33
T_2: Rudrakshya	17.00	2.15	1.46	3.61	43.67	23.67	84.00	303.50	1986.00
T_3: Durga	25.33	2.19	1.56	3.75	53.33	25.00	86.67	325.13	2166.00
T_4: PRA-1	29.67	2.48	2.42	4.90	50.33	25.00	82.67	405.31	2068.00
T_5: PRA-2	39.33	2.88	3.30	6.18	63.33	27.33	92.00	568.75	2516.00
T_6: PRA-3	30.33	2.84	2.64	5.48	57.67	25.33	88.00	482.36	2229.33
T_7: Annapurna	32.00	2.87	3.15	6.02	56.33	27.33	90.67	545.81	2479.33
C.D. @ 1%	2.47	0.17	0.15	0.23	4.03	2.08	8.38	49.76	289.87
SE(m) ±	0.81	0.05	0.05	0.08	1.32	0.68	2.74	16.25	94.65
C.V. (%)	5.31	3.74	3.78	2.72	4.48	4.83	5.54	6.83	7.81

Table 2: Mean performance for different varieties of amaranth on seed quality for electrical conductivity and crude protein

Treatment	ELECTRICAL CONDUCTIVITY (µS/cm))	Crude Protein
T_1: VL-110	10.06	15.817
T_2: Rudrakshya	10.16	14.980
T_3: Durga	9.60	14.320
T_4: PRA-1	9.57	13.770
T_5: PRA-2	7.15	11.883
T_6: PRA-3	7.93	12.583
T_7: Annapurna	8.06	13.723
C.D. @ 1 %	0.19	1.158
SE(m) ±	0.06	0.378
C.V. (%)	1.23	4.723

Table 3: Mean performance of different varieties of amaranth on seed quality for accelerated aging test

Treatment	Accelerating aging test				
	Total Seedling length (cm)	Dry wt. of seedling (mg)	Germination %	Vigour Index-1	Vigour Index-2
T_1: VL-110	3.04	11.67	62.67	190.51	732.00
T_2: Rudrakshya	3.07	12.67	71.33	219.22	903.33
T_3: Durga	3.06	13.33	75.00	229.83	1001.00
T_4: PRA-1	4.38	14.33	79.67	348.75	1141.67
T_5: PRA-2	6.04	19.33	82.00	495.29	1584.67
T_6: PRA-3	6.09	21.00	87.67	533.59	1839.33
T_7: Annapurna	5.05	17.67	80.67	407.11	1425.33
C.D. @ 1%	0.35	1.16	3.76	31.59	92.95
SE(m) ±	0.11	0.38	1.23	10.32	30.35
C.V. (%)	4.51	4.17	2.76	5.16	4.27

Table 4: Mean performance of different varieties of amaranth on seed quality for cold test

Treatment	COLD TEST				
	Seedling length (cm)	Dry wt. of seedling (mg)	Germination %	Vigour Index-1	Vigour Index- 2
T_1: VL-110	3.45	23.33	85.33	294.09	1990.00
T_2: Rudrakshya	3.72	22.67	86.00	320.18	1949.33
T_3: Durga	3.83	23.67	87.33	334.74	2066.00
T_4: PRA-1	4.68	26.00	87.33	409.22	2272.67
T_5: PRA-2	6.03	26.67	94.00	567.21	2507.33
T_6: PRA-3	6.44	27.00	96.00	618.62	2593.33
T_7: Annapurna	5.04	26.00	88.00	443.47	2287.33
C.D. @ 1%	0.10	1.39	5.51	28.95	198.73
SE(m) ±	0.03	0.45	1.80	9.45	64.89
C.V. (%)	1.21	3.14	3.50	3.84	5.02

Table 5: Mean performance of different varieties of amaranth on seed quality under water sensitivity for low moisture (9 ml)

Treatment	Low moisture (9 ml)				
	Germination %	Total seedling length (cm)	Dry weight (mg)	Vigour Index-1	Vigour Index-II
T_1: VL-110	83.33	6.65	16.67	554.24	1358.67
T_2: Rudrakshya	83.33	6.93	23.67	577.43	1926
T_3: Durga	87.33	7.11	25.00	620.59	2134.67
T_4: PRA-1	92.00	8.65	25.00	795.39	2250.67
T_5: PRA-2	88.00	8.12	27.33	715.21	2352
T_6: PRA-3	94.00	9.39	27.33	882.99	2515.33
T_7: Annapurna	92.67	8.76	25.33	812.28	2296
C.D. @ 1%	6.73	0.35	2.08	67.87	279.9
SE(m) ±	2.20	0.12	0.68	22.16	91.4
C.V. (%)	4.29	2.52	4.83	5.42	7.47

Table 6: Mean performance of different varieties of amaranth on seed quality under water sensitivity for high moisture (18 ml)

Treatment	High moisture (18 ml)				
	Germination %	Total seedling length (cm)	Dry weight (mg)	Vigour Index-1	Vigour Index-II
T_1: VL-110	81.33	5.42	16.00	441.19	1338.00
T_2: Rudrakshya	81.33	5.68	24.00	462.37	2003.33
T_3: Durga	85.33	6.09	24.00	520.07	2094.67
T_4: PRA-1	90.00	7.21	26.00	648.78	2421.33
T_5: PRA-2	86.00	6.65	22.67	572.29	1990.67
T_6: PRA-3	92.00	7.39	26.33	680.25	2444.67
T_7: Annapurna	90.67	7.35	26.33	666.39	2441.33
C.D. @ 1%	6.73	0.21	2.01	51.21	245.54
SE(m) ±	2.20	0.07	0.66	16.72	80.18

C.V. (%)	4.39	1.78	4.80	5.08	6.60

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COMPETING INTERESTS

Authors have declared that no competing interests exists.

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