

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

ABSTRACT:

The present investigation was conducted during *kharif* of 2021 at College of Forestry, Ranichauri, Tehri Garhwal of VCSG Uttarakhand University of Horticulture & Forestry, Bharsar, Pauri, Garhwal, Uttarakhand, to investigate the biochemical characteristics of 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, and seedling vigour indices were recorded higher with the treatment 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 with the treatment T₆ (PRA-3). On the basis of this investigation, it could be concluded that treatments T₄ (PRA-1), T₅ (PRA-2), T₆ (PRA-3) and T₇ (Annapurna) induce showed overall better performance for biochemical and seed quality of amaranth.

Keywords: Amaranth, biochemical, seed quality, accelerate ageing

INTRODUCTION

Amaranthus (*Amaranthus spp.*) is considered one of the most important leafy vegetables in India. Amaranthus (*Amaranthus spp.*) is 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 $2n = 32$, $2n = 34$ and $2n = 64$, respectively. *A. cruentus* L. and *A. hypochondriacus* L. are originates from Central America and North America, respectively, whereas *A. caudatus* L. is 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

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Research Council, 1984, Saunders and Becker, 1984). The composition of amaranth is particularly rich in essential amino acids, and its protein content is much higher than conventional food sources like wheat, barley and maize (Venskutonis and Kraujalis, 2013).

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Amaranthus has prominent nutritional value due to the high content of important micronutrients, among them protein (14-19%), carbohydrates (62-66%), fiber (4-5%), fat (6-7%) and ash (2.5-4.4%) (Mlakar *et al.* 2009). Amaranthus is mainly grown from tropical lowlands to 3,500m above mean sea level in the Himalayas (Sauer, 1967). Amaranthus 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). In an overall point of view, seed is an essential element in agriculture, which decides the success of any crop production programme, and the use of good quality of seeds for planting is necessary for the successful production of any crop. So, quality testing has a great importance for the evaluation of varietal superiority in the environment (Kumar *et al.* 2015 and Manikandan *et al.* 2015). The present investigation was carried out 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.

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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. It comprised 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 amaranthus. In laboratory condition, (under standard germination test), it was recorded the following variables: viz. germination percentage, seedling total length, seedling fresh and dry weight, seedling vigour indices, protein content and electrical conductivity test were recorded.

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RESULT AND DISCUSSION

The statistical analysis showed highly significant differences among the varieties for all the traits studied. The mean values for all the experiments are presented in the Tables 1 and 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 this current study, T₅ (PRA-2) had a significant effect on the first count and germination percent of seeds. Similar kind of information were 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 percentage. The seeds germination seems must be a biological process, depending on several factors including the different behaviour of varieties. Similar results were also reported by Kumar *et al.* (2015) in amaranthus.

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A beneficial indicator of seed vigour is the length of the seedlings roots, shoots, and overall length, leading towards better plant establishment. Significantly higher seedling root length, seedling shoot length and total seedling length was recorded in T₅ (PRA-2) (Table 1). The length of the

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seedlings roots and shoots was used to determine its total length. Similar findings were reported by Kumar (2023) ~~with~~ chia seeds and Naseem *et al.* (2007) ~~with~~ buckwheat. ~~Due to differences in the genetic make-up of varieties, V~~variation in seedling root length, seedling shoot length, and overall seedling length of ~~the~~ different varieties were also ~~found to be~~ considerable. ~~Certainty, these variations should be due to different genetic potential among the different varieties studied. 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) ~~with~~ buckwheat.

Maximum seedling growth resulted in better seedling establishment, ~~and~~ higher plant growth and higher yield in ~~the~~ field, ~~results supported by~~ Moshatati *et al.* (2012) ~~with~~ wheat. ~~Again, s~~Significantly highest seedling fresh weight and seedling dry weight was recorded in T₅ (PRA-2). ~~One cause for this variation~~ might be ~~because the~~ food reserves ~~were~~ used more effectively and quickly, resulting in seedlings with higher fresh weight. These findings agreed with Naseem *et al.* (2007) ~~with~~ buckwheat, Arivazhagen and Kadarmohideen (2006) ~~with~~ French bean and Panwar (2023) ~~with~~ 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 ~~also~~ recorded in T₅ (PRA-2) (Table 1). ~~These results~~ 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) ~~with~~ finger millet and Panwar (2023) ~~with~~ quinoa seeds.

Electrical conductivity was found to be maximum in ~~the~~ T₁ (VL-110 - Control) which was statistically *at par* with T₂ (Rudrakshya) and minimum in T₅ (PRA-2). The similar findings were reported by Kumar (2023) ~~with~~ chia seeds. ~~According to Pandey (1992), working with sorghum,~~ ~~W~~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 ~~by the~~ soaking solution indicates high seed vigour and *vice-versa* in soybean (Adriana *et al.*, 2012). The difference in electrical conductivity in ~~the~~ different amaranth varieties might be due to variability in genetic constitution, moisture content and temperature. Crude protein was found maximum in T₁ (VL-110 - Control), which was significantly *at par* ~~with~~ T₂ (Rudrakshya) (Table ...). Similar findings were reported by Bressani (1994) ~~with~~ amaranth, ~~and~~ Gimlinger *et al.* (2007) ~~with~~ 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 significantly ~~on~~ 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 ~~seeds~~ germination percentage, seedling length, dry weight and vigour index-I and ~~v~~vigour index-II were significantly influenced by the cold test (Table 4). The significantly higher ~~seeds~~ germination percentage was recorded in T₆ (PRA-3), ~~but which~~ was statistically *at par* with T₅ (PRA-2) and ~~again,~~ higher seedling length was recorded in T₆ (PRA-3). ~~Again, h~~Higher seedling dry weight was observed in T₆ (PRA-3), ~~but which~~ was statistically *at par* with T₄ (PRA-1), T₅ (PRA-2) and T₇

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(Annapurna) and higher seedling vigour index-I and II was recorded in T₅ (PRA-2) and T₆ (PRA-3) (Table 1). 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 of amaranth being able to resist conditions of cold stress in amaranth. The current findings were in consistent with the findings of Ilyas *et al.* (2022) within *Brassica napus* and Panwar (2023) within 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. In the current study with amaranth, it was observed lower seeds germination 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 with T₆ (PRA-3). The current findings were in consistent with Panwar (2023) within chia seeds, Kapoor *et al.* (2010) within chickpea and Samrah and Al-Kofahi (2008) within barley seeds. According to Gidrol *et al.* (1998), genetic potential of varieties to perform under stress condition and degradation of mitochondrial membrane, leading to reduction in energy supply required for germination.

Germination percentage, seedling length, dry weight, vigour index-I and vigour index-II increased more in low moisture condition than in high moisture condition under water sensitivity test (Table 5). That might be due to the ability of Amaranth plants to grow better under less moisture conditions. 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) (Table 6). and vigour index-I and vigour index-II were observed in T₆ (PRA-3) as being 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) are overall better performance for seed quality and biochemical characters. For being the higher yield and good in quality, the genotypes PRA-1 (T₄), PRA-2 (T₅), PRA-3 (T₆) and Annapurna (T₇) are recommended in hills of Uttarakhand for the cultivation.

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

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S. N ^o	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 1b: Mean performance for different varieties of amaranth on seed quality for standard germination

S. N ^o	Treatment	Seed Germination (%)	Seedlings variables							
			First Count	Shoot length (cm)	Root length (cm)	Length (cm)	Fresh weight (mg)	Dry weight (mg)	Vigour Index-1	Vigour Index-2
T ₁	VL-110	74.67	10.67	2.09	1.31	3.40	31.67	16.67	253.99	1245.33
T ₂	Rudrakshya	84.00	17.00	2.15	1.46	3.61	43.67	23.67	303.50	1986.00
T ₃	Durga	86.67	25.33	2.19	1.56	3.75	53.33	25.00	325.13	2166.00
T ₄	PRA-1	82.67	29.67	2.48	2.42	4.90	50.33	25.00	405.31	2068.00
T ₅	PRA-2	92.00	39.33	2.88	3.30	6.18	63.33	27.33	568.75	2516.00
T ₆	PRA-3	88.00	30.33	2.84	2.64	5.48	57.67	25.33	482.36	2229.33
T ₇	Annapurna	90.67	32.00	2.87	3.15	6.02	56.33	27.33	545.81	2479.33
C.D. @ 1%		8.38	2.47	0.17	0.15	0.23	4.03	2.08	49.76	289.87
SE(m) ±		2.74	0.81	0.05	0.05	0.08	1.32	0.68	16.25	94.65
C.V. (%)		5.54	5.31	3.74	3.78	2.72	4.48	4.83	6.83	7.81

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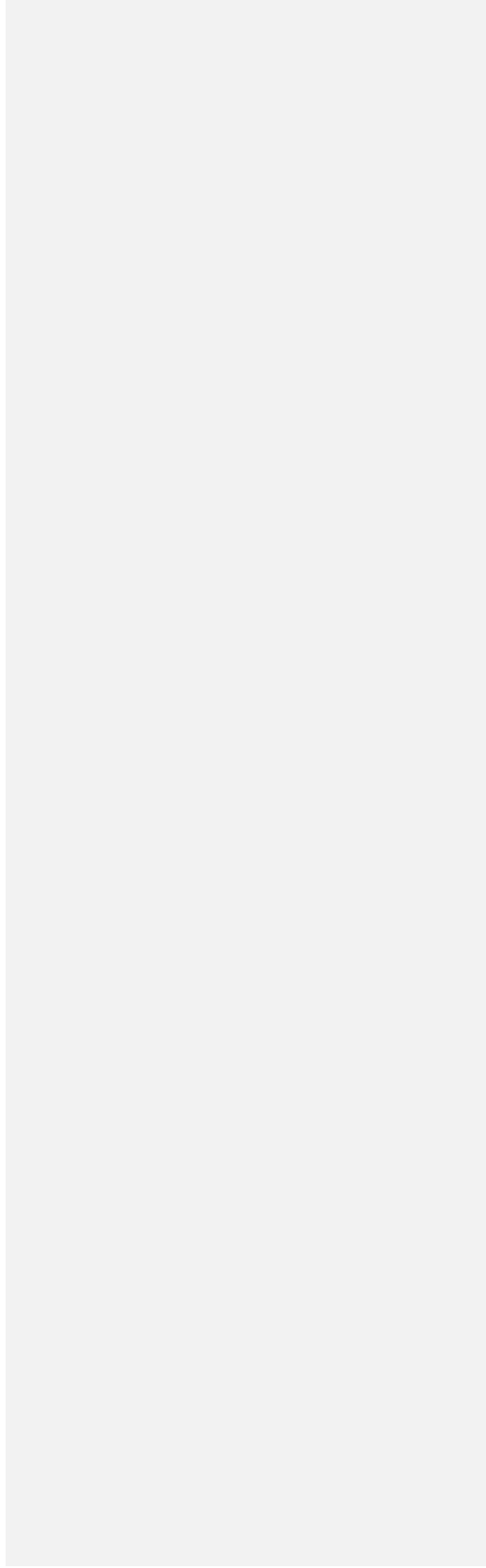


Table 1: Mean performance for different varieties of amaranth on seed quality for standard germination

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	
VL-110	10.67	2.09	1.31	3.40	31.67	16.67	74.67	253.99	1245.33	
Rudrakshya	17.00	2.15	1.46	3.61	43.67	23.67	84.00	303.50	1986.00	
Durga	25.33	2.19	1.56	3.75	53.33	25.00	86.67	325.13	2166.00	
PRA-1	29.67	2.48	2.42	4.90	50.33	25.00	82.67	405.31	2068.00	
PRA-2	39.33	2.88	3.30	6.18	63.33	27.33	92.00	568.75	2516.00	
PRA-3	30.33	2.84	2.64	5.48	57.67	25.33	88.00	482.36	2229.33	
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)±	0.84	0.05	0.05	0.08	1.32	0.68	2.74	16.25	94.66	
C.V. (%)	5.31	3.74	3.78	2.72	4.48	4.83	5.54	6.83	7.81	

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

S. N ^o	Treatment	COLD TEST
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		Seedling length (cm)	Dry weight of seedling (mg)	Germination (%)	Vigour Index-1	Vigour Index- 2
<u>I₁</u>	<u>T₁</u> : VL-110	3.45	23.33	85.33	294.09	1990.00
<u>I₂</u>	<u>T₂</u> : Rudrakshya	3.72	22.67	86.00	320.18	1949.33
<u>I₃</u>	<u>T₃</u> : Durga	3.83	23.67	87.33	334.74	2066.00
<u>I₄</u>	<u>T₄</u> : PRA-1	4.68	26.00	87.33	409.22	2272.67
<u>I₅</u>	<u>T₅</u> : PRA-2	6.03	26.67	94.00	567.21	2507.33
<u>I₆</u>	<u>T₆</u> : PRA-3	6.44	27.00	96.00	618.62	2593.33
<u>I₇</u>	<u>T₇</u> : 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

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

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S. N ^o	Treatment	Low moisture (9 ml)				
		Germination (%)	Total seedling length (cm)	Dry weight of seedling (mg)	Vigour Index-1	Vigour Index-II
<u>I₁</u>	<u>T₁</u> : VL-110	83.33	6.65	16.67	554.24	1358.67
<u>I₂</u>	<u>T₂</u> : Rudrakshya	83.33	6.93	23.67	577.43	1926
<u>I₃</u>	<u>T₃</u> : Durga	87.33	7.11	25.00	620.59	2134.67
<u>I₄</u>	<u>T₄</u> : PRA-1	92.00	8.65	25.00	795.39	2250.67
<u>I₅</u>	<u>T₅</u> : PRA-2	88.00	8.12	27.33	715.21	2352
<u>I₆</u>	<u>T₆</u> : PRA-3	94.00	9.39	27.33	882.99	2515.33
<u>I₇</u>	<u>T₇</u> : Annapurna	92.67	8.76	25.33	812.28	2296

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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

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

S. N ^o	Treatment	High moisture (18 ml)				
		Germination (%)	Total seedling length (cm)	Dry weight (mg)	Vigour Index-1	Vigour Index-II
I ₁	T ₄ : VL-110	81.33	5.42	16.00	441.19	1338.00
I ₂	T ₂ : Rudrakshya	81.33	5.68	24.00	462.37	2003.33
I ₃	T ₃ : Durga	85.33	6.09	24.00	520.07	2094.67
I ₄	T ₄ : PRA-1	90.00	7.21	26.00	648.78	2421.33
I ₅	T ₅ : PRA-2	86.00	6.65	22.67	572.29	1990.67
I ₆	T ₆ : PRA-3	92.00	7.39	26.33	680.25	2444.67
I ₇	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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