Original Research Article

Assessing Chilli Genotypes: A Study of Morphological and Nutritional Traits

ABSTRACT

Capsicum spp., a member of the Solanaceae family, is a widely used vegetable crop that is mostly used as a spice, condiment, medicine, and vegetable. It is also a major source of vitamins A and C. There are about 22 wild and five cultivated species in the genus Capsicum. *C. annuum, C. baccatum, C. Chinense, C. frutescens* and *C. pubescens* are the species that are grown. Indian chilli peppers have become a major player in the world market for chili peppers. India is the world's biggest producer, consumer, and exporter of chilli, making it unique in the world market. Over 40 per cent of the world's total chilli production comes from India. Plant height ranged from 66.83 to 84.65 cm, while yield varied from 4699.08 to 7115.75 kg/ha. There was a noticeable variation in moisture content, ranging from 6.36 (JCH-788) to 8.37 (JCH-785) percent. JCH-799 had the lowest protein content (12.90%) while Gholar had the highest concentration (15.52%). Similarly, the percentage of carbohydrates ranged from 61.93 percent (in GCh-3) to 69.69 percent (in JCH-785). JCH-18-835 and Kashmiri had the highest ascorbic acid contents, ranging from 76.92 to 112.82 mg/100 gm. Total phenol content was found in Kashmiri to be 2.14 percent, with JCH-18-832 having the lowest levels at 1.75 percent. These findings show that there is genetic diversity amongst chilli varieties, which can be leveraged to create high-yielding varieties with improved nutritional value.

Keywords: chilli, morphological, nutrition, biochemical, yield

1. INTRODUCTION

The sensation of taste includes five established basic tastes: sweetness, sourness, saltiness, bitterness, umami and spiciness. Few substances cause a burning sensation by inducing a trigeminal nerve reaction together with normal taste reception. Some such plant-derived compounds that provide this sensation are capsaicin from chilli peppers, piperine from black pepper and gingerol from ginger root. Chilli (*Capsicum* spp., *Solanaceae*), is an important vegetable crop mostly used as spice, condiment, medicine, vegetable and a significant source of vitamin A and C throughout the world (Chakrabarty *et al.,* 2017). The native home of chilli is considered to be New Mexico with secondary origin to be Guatemala. They are known from pre-historic remains of Peru. Chilli was introduced into Spain in 1493 and later spread to Europe. Chilli was introduced into India by Portuguese in 16th century (Madala and Nutakki, 2020).

Chilli (*Capsicum annuum* L.), known colloquially as hot, bell and sweet pepper or cayenne (in English), tianjio (in Chinese), poivron (in French) and paprika (in German), is classified taxonomically within the genus Capsicum of the Solanaceae family. It is a diploid plant with a chromosomal count of 2n = 2X = 24 and is cultivated annually as a short-duration perennial. The genus Capsicum comprises approximately 22 wild and five cultivated species. The

cultivated species are *C. annuum, C. baccatum, C. Chinense, C. frutescens*and *C. pubescens.* Significant distinctions among these species are observed in the shape, size and colour of fruits, the fruit-bearing habit (erect or pendent, solitary or clustered) and the pungency of fruits. Notably, *C. annuum* stands out as the most widely cultivated species globally (Bosland, 1996).

Chilli pepper pods, botanically classified as berries, are widely employed in culinary contexts. Fresh pods are primarily utilised as a vegetable, while whole pods undergo a drying process to produce chilli powder, a ubiquitous spice or seasoning. This drying process not only extends the shelf life of chilli but also facilitates its storage. In addition, chilliis occasionally used whole or in large pieces. In Indian cuisine, households typically maintain a readily available stock of fresh hot green chilli peppers, frequently utilising them to enhance the flavour of various curries and dry dishes. Notably, they are often lightly fried with oil during the initial stages of dish preparation.

Indian chilli peppers have emerged as a dominant force in the global chilli market. India holds the distinction of being not only the largest producer but also the largest consumer and exporter of chilli worldwide. Chilli alone accounts for 42 per cent of the total spice export volume from the country and is primarily shipped to nations such as China, Vietnam, Thailand, Sri Lanka, Indonesia and Malaysia. Indian chilli is renowned internationally for its significant commercial attributes, notably its vibrant colour and pungency levels. India leads global chilli production, contributing 1.98 million tons and encompassing 43 per cent of the world's chilli output. India is followed by in chilli production are China, Ethiopia, Thailand, Pakistan and Bangladesh in chilli production (ANGRU Chilli Outlook Report, 2022).

India accounts more than 40 per cent of total chilli production of the world. In the year 2023, chilli production and productivity were recorded 64000 metric tons in the 278050 hectors in India, with Gujarat ranking 7th among states in India with a production of 22,910 metric tonnes (Source: Spice Board of India). Noteworthy chilli-growing states in India include Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka, Odisha, West Bengal and Gujarat. In the view of above, the present investigation was planned to check the morphological and nutritional attributes of different chilli varieties/genotypes.

2. MATERIAL AND METHODS

The present investigation was conducted at the Department of Biochemistry, College of Basic Science and Humanities, Sardarkrushinagar Dantiwada Agricultural University (SDAU) and the Vegetable Research Station, SDAU. Fourteen distinct chilli varieties/genotypes were cultivated at the Vegetable Research Station, SDAU. Upon reaching maturity, red colouration, the chilli fruits were harvested and subjected to shed drying and subsequently were utilised for investigation. Yield and plant height were statistically analysed by RBD, while biochemical analysis were statistically analysed by CRD with three replications.

2.1 Plant Height and Yield

Plant height of 5 randomly selected plants of each variety was measured from the base of the stem to the apex of the central leaf at the time of harvest and average was worked out and expressed in centimeters. Total yield per plant from each selected plant as well as per plot were recorded and converted into fruit yield kilogram per hectare.

Preparation of Chilli Powder

Chilli fruits were collected at the red maturity stage from each plant within the designated plot, subsequently combined and subjected to drying in a shaded area. Following this, the

dried fruits underwent grinding in a mixer grinder. The resultant powder was sifted through a mesh sieve with a size of 20 and employed for subsequent analytical procedures.

2.2 Moisture

The weighted sample of powder was dried at 105°C in a hot air oven for five hours to evaluate the moisture content of the powder; the weight loss was then expressed as the moisture content (A.O.A.C., 2000). Each sample was weighed on pre-weighed petri dishes and the moisture content was determined using the following formula.

$$\text{Moisture (\%)} = \frac{(\text{Fresh weight} - \text{Dry weight})}{\text{Fresh weight}} \text{ X } 100$$

2.3 Protein

The determination of protein content followed the protocol outlined by Lowry *et al.* (1951). One gram of sample from each variety was weighed and subsequently homogenized in five ml of 0.1 N NaOH and then was filtered through Whatman No.1 filter paper. From the resulting sample extracts, 0.2 ml was withdrawn and diluted to a volume of three ml with distilled water. Subsequently, five ml of alkaline copper solution (comprising 50 ml of 2% sodium carbonate in 0.1 N NaOH and one ml of 0.5% copper sulphate in 10% sodium potassium tartrate) was added. Following a ten minutes incubation period at room temperature, 0.5 ml of Folin-Ciocalteu reagent solution (in a 1:1 v/v ratio) was introduced. The mixture was allowed to stabilize for an additional 30 minutes at room temperature, after which absorbance was measured at 750 nm. Protein content was calculated using bovine serum albumin as a standard within the range of 20 to 100 µg/ml.

$$\text{Protein (\%)} = \text{Graph factor x } \frac{\text{Sample reading}}{\text{weight of sample}} \text{x} \frac{\text{Total volume}}{\text{Taken volume}} \text{x } 10^{-4}$$

2.4 Carbohydrates

Chilli powder (1 gm) underwent homogenization in two normal hydrochloric acid using a mortar and pestle, followed by adjustment of volume to 20 ml. The resulting mixture was subjected to reflux for one hour on a water bath maintained at 70°C. The supernatant was collected and the residue underwent two additional extractions with two normal HCl. All supernatants were combined and the final volume was adjusted to 50 ml. This extract was then utilised for the determination of total carbohydrates, following the Anthrone method as proposed by Ludwing and Goldberg (1956). A 0.5 ml aliquot of the extract was withdrawn and diluted to one ml with distilled water. Subsequently, four ml of Anthrone reagent (0.2%) was carefully added. After thorough mixing, the tubes were subjected to a ten minutes incubation period in a boiling water bath. Following rapid cooling, absorbance was measured at 630 nm. Carbohydrate content was calculated utilising glucose as a standard within the range of 20 to 100 µg/ml.

$$\text{Carbohydrates (\%)} = \text{Graph factor x } \frac{\text{Sample reading}}{\text{weight of sample}} \text{x} \frac{\text{Total volume}}{\text{Taken volume}} \text{x } 10^{-4}$$

2.5 Ascorbic Acid

The determination of ascorbic acid content followed the procedure outlined in Sadasivam and Manickam (1996). Initially, solutions of oxalic acid (4%) and a working standard solution (0.1 mg/ml) was prepared. Five ml of the working standard solution were dispensed into a conical flask, followed by the addition of ten ml of oxalic acid (4%). The resulting solution was titrated against a dye solution of 2,6-dichlorophenol indophenol (prepared by dissolving 42 mg of sodium bicarbonate and 52 mg of 2,6-dichlorophenol indophenol in 200 ml of distilled water) and the volume consumed was recorded as V1 (in ml).Additionally, one gram of chilli powder was homogenized with ten ml of oxalic acid (4%). This process was repeated twice and the resulting extracts were combined with the volume adjusted to 100 ml using oxalic acid. Five ml of the extract was then mixed with ten ml of oxalic acid and titrated against the 2,6-dichlorophenol indophenol dye solution. The volume consumed was recorded as V2 (in ml). The ascorbic acid content (in mg/100gm) was subsequently calculated using the following formula.

$$\text{Ascorbic acid } (\frac{\text{mg}}{100\text{gm}}) = x = \frac{0.5 \text{ mg}}{V_1 \text{ ml}} \text{ x } \frac{V_2 \text{ ml}}{15 \text{ ml}} \text{x} \frac{100 \text{ ml}}{\text{Weight of sample}} \text{x } 100$$

2.6 Total Phenols

The sample weighing one gram was homogenized in methanol (80%) using mortar and pestle and the final volume was adjusted to ten ml. Subsequently, the mixture was refluxed for duration of two hours on a water bath maintained at 65°C. The resulting supernatant was collected while the residue underwent two additional extractions with methanol (80%). The combined supernatants were adjusted to a final volume of 25 ml. This extract was then utilised for the determination of total phenols. Total phenol content was assessed according to the method described by Akpata *et al.* (2023), with minor modifications. A 0.5 ml aliquot of the extract was withdrawn and diluted to a final volume of one ml with distilled water. Folin–Ciocalteu reagent (0.5 ml) was added, followed by the addition of two ml of sodium carbonate (20%) solution. The resulting mixture was incubated in a boiling water bath for one minute. After cooling, the total volume of each tube was adjusted to ten ml with distilled water and absorbance was measured at 650 nm. Phenol content was calculated utilising a standard curve prepared from catechol.

$$\text{Total Phenols } (\%) = \text{Graph factor x } \frac{\text{Sample reading}}{\text{weight of sample}} \text{x} \frac{\text{Total volume}}{\text{Taken volume}} \text{x } 10^{-4}$$

3. RESULTS AND DISCUSSION

3.1 Yield and Plant height

In the present study, yield and plant height data were recorded from 14 chilli varieties/genotypes cultivated at the Vegetable Research Station of S. D. Agricultural University, Sardarkrushinagar and data are presented in the Table 1. The recorded average yield among the different genotypes ranged from 4699.08 to 7115.75 kg/ha, with an overall average yield of 5503.64 kg/ha. Notably, the genotype JCH-18-832 exhibited the highest yield at 7115.75 kg/ha, which was statistically comparable to the yields of the genotype Reshampatti (6231.49 kg/ha) and the variety GCh-1 (6282.41 kg/ha). Conversely, the genotype JCH-788 produced the lowest yield at 4699.08 kg/ha. Plant height measurements ranged from 66.83 to 84.65 cm, with an overall average height of 75.11 cm. Interestingly, the

genotype JCH-18-832, which recorded the highest yield, also had the lowest plant height at 66.83 cm, suggesting a negative correlation between yield and plant height. The genotype JCH-18-826 was noted for having the highest plant height at 84.65 cm. These findings indicate a potential trade-off between plant height and yield, which could be an important consideration in the selection and breeding of chilli genotypes for optimal production. The negative correlation observed suggests that shorter plants might be more efficient in allocating resources towards fruit production rather than vegetative growth. This could be advantageous for breeding programs aiming to enhance yield without necessarily increasing plant size, which might also have implications for plant management and harvesting efficiency. Further studies could explore the underlying physiological mechanisms driving this relationship and assess how these insights can be applied to improve chilli cultivation practices.

Biochemical analysis of chilli entails investigating numerous components found in chilli that contribute to its flavour, colour and health advantages.

Table 1. Variation in Yield (kg/ha) and Plant Height (cm) in 14 Varieties/Genotypes of Chilli

Varieties/Genotypes	Yield (kg/ha)	Plant height (cm)
GCh-1	6282.41	71.04
GCh-2	5504.63	72.46
GCh-3	5013.89	76.05
JCH-756	5328.71	73.63
JCH-785	5138.89	76.15
JCH-788	4699.08	77.63
JCH-799	5148.15	71.91
JCH-802	5083.34	75.20
JCH-18-826	5282.41	84.65
JCH-18-832	7115.75	66.83
JCH-18-835	5773.15	82.30
Reshampatti	6231.49	74.14
Gholar	5578.71	76.24
Kashmiri	4870.37	73.30
S. Em. ±	**325.52**	**0.88**
CD at 5%	**946.50**	**2.57**
C.V. %	**10.24**	**2.04**

3.2 Moisture

The fresh chillis have a moisture content ranging from 80 to 90 per cent by weight. However, this percentage can decrease significantly during processing and drying to produce chilli powder or oleoresin. Chilli processing involves steps like washing, drying and grinding. During drying, the moisture content is reduced to around eight to ten per cent in dried chillis, while chilli powder may have a moisture content of approximately five to eight per cent (Sharma *et al.,* 2017). It is important to note that moisture content impacts the shelf life and quality of chilli products with lower moisture levels typically associated with better stability and preservation of flavour and nutrients. The moisture content of various chilli varieties/genotypes was determined and is presented in the Table 2. The moisture content

varied significantly from 6.36 to 8.37 per cent among the varieties/genotypes. This variation is caused due to genetic differences, environmental factors and agricultural practices. JCH-785 significantly exhibited the highest moisture content (8.37%), indicating higher water content in this genotype. This could be due to its specific genetic traits or growth conditions that promote water retention. On the other end of the spectrum, JCH-788 had the lowest moisture content (6.36%). The findings of this study are consistent with (Sharma *et al.,* 2017), where they reported moisture content levels of 8.4 per cent for *Capsicum chinense* and 8.2 per cent for *Capsicum annuum*. Similarly, in a separate study conducted by Krithika and Sri (2014), the moisture content of different chilli cultivars ranged from 7.8 to 8.6 per cent.

3.3 Protein

The protein content of chilli powder varies depending on the type of chilli and how it is processed. On average, chilli powder contains 12-15 per cent protein (Sharma *et al.,* 2017). This study evaluated the protein content of 14 different chilli varieties/genotypes and the results are provided in Table 2. The reported protein content ranged from 12.90 to 15.52 percent. Notably, the JCH-799 variety had the lowest protein level at 12.9 per cent, which was comparable to the genotype JCH-18-832 (13.07%), while the Gholar genotype had the highest protein content at 15.52 per cent. These findings highlight the significant protein content heterogeneity found across different chilli genotypes. The findings of this investigation are consistent with Kamal *et al.* (2019), who suggested resilience in measuring protein content in chilli varieties, reinforcing the reliability of these results and revealing underlying protein composition variances among genotypes. Protein concentration may vary due to genetic characteristics, climatic conditions and agronomic practices, which are critical for optimising protein levels and selecting desired nutritional profiles. Finally, this work contributes to a better understanding of chilli's nutritional diversity which will help breeders, researchers and producers optimise nutritional profiles and increase crop value.

3.4 Carbohydrates

The carbohydrate content of chilli powder varies greatly depending on the variety of chilli used, ripeness at harvest and processing. These variances lead to the varying nutritional profiles reported in different varieties of chilli powder. The carbohydrate level of chilli powder can have nutritional ramifications, especially for people who follow certain diets like low-carb or ketogenic. Understanding the changes in carbohydrate content in chilli varieties is critical for many stakeholders, including breeders, researchers and food processors. It permits the selective selection of genotypes with desired nutritional profiles or functional features, such as higher or lower carbohydrate content, for specific dietary requirements or product formulation. In conclusion, the carbohydrate content assessment provides useful insights into the nutritional heterogeneity of chilli genotypes allowing for more informed decision-making in agricultural and food science contexts. In this study, carbohydrate content was assessed and the results are shown in Table 2. The carbohydrate content assessment indicates a wide range of values, ranging from 61.93 to 69.69 percent throughout the studied varieties/genotypes. Among the types studied, GCh-3 had the lowest carbohydrate content (61.93%). This data demonstrates that chilli genotypes have inherent differences in carbohydrate accumulation, underlining the need of genotype selection for specific nutritional needs or processing goals. Conversely, JCH-785 has the highest carbohydrate content (69.69%), compare to Reshampati, Gholar and GCh-1. This similarity suggests that certain genotypes may have comparable carbohydrate composition properties, despite differences in other nutritional or agronomic characteristics. Kamal *et al.* (2019) assessed the carbohydrate content of both fresh and dried chilli powder. Their investigation revealed that fresh chilli has a relatively low carbohydrate level of 4.99 per cent. In comparison, the

carbohydrate content of chilli powder varied widely, ranging from 64.81 to 68.08 per cent. This considerable variation in carbohydrate content between fresh and powdered chilli highlights the effect of processing methods, such as drying and grinding, on the nutritional makeup of chilli.

3.5 Ascorbic Acid

Ascorbic acid, also known as vitamin C, is a vital nutrient found in various foods, including chilli powder. Its presence in chilli powder not only enhances the nutritional profile of this popular spice but also contributes to its potential health benefits. Ascorbic acid is a water-soluble vitamin renowned for its antioxidant properties which play a crucial role in protecting cells from oxidative damage caused by free radicals (Padayatty *et al.,* 2003). Therefore, understanding the ascorbic acid content in chilli powder is essential for assessing its nutritional value and potential impact on human health. Research focusing on the ascorbic acid content of chilli powder provides valuable insights into its role in promoting health and well-being, considering these facts the 14 varieties/genotypes were evaluated in this study for the ascorbic acid content and results are depicted in the Table 2. The concentration of ascorbic acid varied from 76.92 to 112.82 mg/100gmamong the samples of dried chilli powder. The Kashmiri genotype demonstrated the highest content of ascorbic acid (112.82 mg/100gm). This concentration was statistically comparable to that of the GCh-2 variety. In contrast, the JCH-18-835 genotype exhibited notably lower levels of ascorbic acid with a concentration of 76.92 mg/100gm. This variation reflects the genetic diversity among chilli varieties and their nutritional compositions. These findings align with a prior study conducted by Litoriya (2008), which also observed varying concentrations of ascorbic acid in the range of 76.3 to 161.3 mg/100gm. Sonaniya *et al.* (2022) also reported that ascorbic acid content ranged from 92.38 to 175.85 mg/100gm with a mean performance of 142.94 mg/100gm. However, another study conducted by Kamal *et al.* (2019) reported a narrower range of ascorbic acid content, ranging from 69.55 to 74.09 mg/100gm, indicating potential variability or differences in the samples studied or in analytical methods employed. Overall, these results highlight the diversity in ascorbic acid content among different chilli genotypes and underscore the importance of considering such variations in nutritional analyses and product formulations.

3.6 Total Phenols

Phenolic molecules serve as antioxidants, scavenging damaging free radicals and shielding plant cells from oxidative stress induced by environmental factors such as UV radiation, pollution and infections. Phenols also help plant defence mechanisms by reducing the growth of pathogens such as bacteria, fungus and viruses. They can also stimulate the synthesis of phytoalexins, which are antibacterial chemicals that help fight infections. Phenols are helpful not only to plants but also to human health because of their antioxidant qualities, anti-inflammatory effects, cardiovascular health, cancer prevention, neuroprotective benefits, immune system support, skin health and metabolic health (Kumar and Goel, 2019). According to studies, chilli powder can contain a high concentration of phenolic components such as flavonoids, phenolic acids and other polyphenols. However, the exact proportion of phenols varies greatly depending on the origin and quality of the chilli powder. Total phenol content was checked from all the 14 varieties/genotypes and the result is presented in the Table 2. The measured total phenol concentration range of 1.75 to 2.14 per cent demonstrates the variable phenolic composition found in the tested chilli cultivars. This diversity reflects the genetic heterogeneity present in chilli cultivars. The Kashmiri genotype has the highest phenol content (2.14%) whilst the JCH-18-832 genotype has the lowest (1.75%). This variance demonstrates the considerable variability in phenolic profiles, even among closely related genotypes. Girish et *al.* (2019) investigated the response of a

chilli genotype to yellow mite infestation, with phenol content ranging from 16.80 to 22.80 mg/g, demonstrating the effect of environmental stresses on phenolic compound production. This shows that external variables can have a considerable impact on phenol concentration in chilli plants. The study by Krithika and Sri (2014), which revealed phenol concentration ranging from 2.35 to 2.75 percent, provides context and comparison with previous research, demonstrating diversity in phenol content across different studies and chilli cultivars. This study helps to understand the complex interaction among genetic variables, environmental stresses and phenol concentration in chilli genotypes. This understanding is essential for agricultural methods, breeding initiatives and improving the nutritional value of chilli cultivars.

Table 2. Study on Variation in Moisture (%), Protein (%), Carbohydrate (%), Ascorbic acid (mg/100gm) and Total Phenols (%) in Chilli Powder of 14 Varieties/Genotypes

Varieties/Genotypes	Moisture (%)	Protein (%)	Carbohydrate (%)	Ascorbic acid (mg/100gm)	Total Phenols (%)
GCh-1	7.39	14.55	66.85	95.73	2.09
GCh-2	7.35	15.27	62.03	105.98	1.98
GCh-3	7.51	15.19	61.93	88.89	1.89
JCH-756	7.47	14.58	65.65	94.02	2.07
JCH-785	8.37	15.12	69.69	92.31	2.00
JCH-788	6.36	14.15	65.65	97.44	2.02
JCH-799	7.45	12.90	64.22	85.47	1.80
JCH-802	7.23	14.22	64.33	88.89	1.88
JCH-18-826	7.47	14.51	64.55	95.73	2.08
JCH-18-832	6.42	13.07	63.35	85.47	1.75
JCH-18-835	7.57	14.40	65.86	76.92	1.77
Reshampatti	6.52	14.40	68.27	90.60	1.93
Gholar	6.62	15.52	66.74	94.02	2.05
Kashmiri	6.85	15.23	65.43	112.82	2.14
S. Em. ±	**0.18**	**0.33**	**1.36**	**2.78**	**0.05**
CD at 5%	**0.52**	**0.97**	**3.95**	**8.05**	**0.16**
C.V. %	**4.31**	**3.98**	**3.61**	**5.17**	**4.78**

4. CONCLUSION

In this investigation encompassing 14 distinct chilli varieties or genotypes, a notable diversity in quality traits was observed.. The yield and plant height were observed 4699.08 to 7115.75 kg/ha and 66.83 to 84.65 cm, respectively. In case of biochemical observations the moisture, protein, carbohydrate, ascorbic acid and total phenols were ranged from 6.36 to 8.37%, 12.90 to 15.52%, 61.93 to 69.69%, 76.92 to 112.82 mg/100gm and 1.75 to 2.14%, respectively. The morphological and biochemical characteristics of chillis exhibit variability influenced by a multitude of factors including cultivar type, environmental conditions, harvesting methodologies and post-harvest treatments.

REFERENCES

Akpata EI, Ani ON, Nwodo OFC. Phytonutrients and Anti-Nutrient Composition of Aqueous Extract of Fermented Seeds of Prosopis africana. Asian Journal of Research in Biochemistry. 2023;13(3):12–27.

AOAC. Official Methods of Analysis. Association of official analytical chemists.Inc. 17th ed. Arlington Virginia. USA. 2000.

Bosland PW. Capsicums: Innovative uses of an ancient crop. *Int: J. Janick (ed.)* Progress in new crops. ASHS Press Arlington Virginia USA. 1996; pp.479-487.

Chakrabarty S, Islam AKM, Islam AKM. Nutritional benefits and pharmaceutical potentialities of chili: A Review. Fundamental and Applied Agriculture. 2017;2:2518-2021.

Girish R, Srinivasa N, Basanth YS, Shruthi HR. Response of chilli genotypes to yellow mite *Polyphagotarsonemus latus* Banks population and biochemical basis of resistance. Journal of Entomology and Zoology Studies. 2019;7(1):250-255.

Kamal MM, Ali MR, Rahman MM, Shishir MRI, Yasmin S, Sarker MSH. Effects of processing techniques on drying characteristics physicochemical properties and functional compounds of green and red chilli (*Capsicum annum* L.) powder. Journal of Food Science and Technology. 2019;56(7):3185-3194.

Krithika V, Sri SR. Physicochemical and nutritional characteristics of chilli cultivars. ScieXplore International Journal of Research in Science. 2014;1(2): 117.

Kumar N, Goel N. Phenolic acids: Natural versatile molecules with promising therapeutic applications. Biotechnology Reports. 2019;24:e00370.

Litoriya NS. Varietal identification of chillies (*Capsicum annuum* L.) using biochemical and molecular markers. A thesis submitted to Anand Agricultural University Anand – 388110. 2008.

Lowry OH, Rosenbrough NJ, Farr L, Randall RJ. Protein measurement with the folin phenol reagent. J. Biol. Chem. 1951;193:265-275.

Ludwig TG, Goldberg HJV. The anthrone method for the determination of carbohydrates in foods and in oral rinsing. Journal of Dental Research. 1956;35(1):90-94.

Madala N and Nutakki MK. Hot pepper-history-health and dietary benefits & production. International Journal of Current Microbiology and Applied Sciences. 2020;9(4):2532-2538.

Padayatty SJ, Katz A, Wang Y, Eck P, Kwon O, Lee JH, Chen S, Corpe C, Dutta A, Dutta SK, Levine M. Vitamin C as an antioxidant: evaluation of its role in disease prevention. Journal of the American College of Nutrition. 2003;22(1):18-35.

Sadasivam S, Manickam A. Biochemical methods. II ed. New Age International Publishers New Delhi. 1996;pp:184-185.

Sharma J, Sharma P, Sharma B, Chaudhary B. Estimation of proximate composition of selected species of capsicum (*Capsicum annuum* and *Capsicum chinense*) grown in India. International Journal of Pure & Applied Bioscience. 2017;5:369–372.

Sonaniya R, Sinh SK, Shukla RS, Bagde VP. Determination of phenols ascorbic acid capsaicin and colour values in chilli (*Capsicum annuum* L.). The Pharma Innovation Journal. 2022;11(8):801-808.