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Influence of harvest maturity on quality parameters in paprika (*Capsicum annuum* L.)

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Abstract

The experiment on the influence of three different harvest stages viz., turning stage, red ripe stage and withering stage on quality parameters of paprika revealed that oleoresin, colour and capsaicin increased with the age of the fruit, ie these characters were found to increase from turning stage to withering stage. Ascorbic acid increased from turning stage to red ripe stage and then declined in the withering stage. The study observed significant influence of both genotypes and harvest maturity on biochemical parameters of paprika. CA 5 had the highest oleoresin content (21.13 per cent) when harvested at withering stage. Ascorbic acid was high in CA 38 (185.07 mg/100g) at red ripe stage. CA 37 recorded the maximum colour values when harvested at withering stage (200.32 ASTA units). Capsaicin content was maximum in CA 10 (0.99%) at withering stage and lowest in CA 38 (0.08%) at turning stage.

Keywords: *Capsicum annuum*, chilli, capsaicin, capsanthin, oleoresin, harvest maturity

Introduction

The genus *Capsicum* is renowned for its affluence in diversity with respect to pungency, colour and shape and size. Chilli [*Capsicum annuum* (L.) is an important vegetable cum spice crop rich in vitamins yielding capsaicin, oleoresin and extractable colour. It includes all the commercially important types' viz., red pepper, paprika, cayenne, chilli and sweet pepper. Paprika is the high coloured low pungent chilli, mainly used for its rich red colour, although in fresh form it contributes a special delicate flavour. Paprika is defined in the world market as non-pungent brilliant red ground capsicum powder, derived from the dried red pods with most of the seeds and veins removed. Value addition of spices holds a great potential for India with the global food industry increasing towards oleoresins and oils with a natural flavour. Paprika is gaining momentum in the international scenario for its high colour and low pungency. It is an ideal source for the extraction of oleoresin. Oleoresin is swiftly gaining momentum in the export market as a proxy for chilli powder. Paprika is an exceptional source of brilliant red colour. The natural red colour from paprika can be used for colouring food products. Green fruits of paprika are quite rich in ascorbic acid. In-spite of the economic importance and great demand for high quality oleoresin and colour in the international market, very little efforts have been made in the country to make it a remunerative enterprise. Sustainable efforts are required for genetic amelioration of the crop to develop improved as well as high yielding varieties with desirable adjustments between yield and quality parameters.

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Materials and methods

Fifty-three genotypes of paprika including the released varieties Arka Abir and Kt-Pl 19 were evaluated at Research Farm, Department of Olericulture, College of Agriculture, Thiruvananthapuram, Kerala during 2012. The crop was grown in a randomized block design with three replications at spacing of 45 × 45 cm. The crop was raised by adopting standard package of practices recommended by Kerala Agricultural University. Fruits were harvested at three different stages of maturity [M1 (Turning stage): stage when mature fruit just starts changing its colour to intermediate stage; M2 (Red ripe stage): stage when fruit becomes fully ripe, but firm and succulent in nature; and M3 (Withering stage): stage when the fully ripe fruit has become shriveled in appearance] from each genotype and studied quality parameters. The experiment formed a factorial RBD with 53 genotypes, three maturity stages and three replications. Fresh fruits were used to estimate ascorbic acid content. Dried fruits at three stages of maturity were powdered

and evaluated for the quality characters like oleroresin, colour and capsaicin.

Results and Discussion

In the case of paprika quality parameters hold significant importance as the economic value of the crop is directly linked with the superior quality parameters. In the present study, different genotypes showed variation in quality characters like colour, oleoresin, capsaicin and ascorbic acid content (Table 1 & 2). Oleoresin represents the total flavour extract of ground spice and consists of fixed oil, capsaicin, pigments, sugars and resin. They are now being extensively used in processed foods and pharmaceutical products. The present study unraveled considerable variation among the genotypes of paprika for oleoresin content. At turning stage CA 25 (15.67%) had maximum oleoresin which was on par with CA 29 (15.50%). CA 8 had the minimum oleoresin content (7.34%) at turning stage. The fruits of CA 7 (18.09%) had maximum oleoresin content which was on par with CA 28 (18.00%) when harvested at full ripe stage, whereas CA 8 (8.45%) recorded minimum oleoresin content at this stage. When fruits were harvested at withering stage CA 5 had highest oleoresin content 21.13%. CA 23 had the lowest content (9.83%) at withering stage. The maximum oleoresin content was recorded when fruits were harvested at withering stage. The interaction of genotypes with maturity stage was also significant. Considering genotypes with maturity stages, CA 5 had highest oleoresin content (21.13%) when harvested at withering stage which was on par with CA 6 (20.83%) when fruits were harvested at withering stage. The interaction of genotypes with maturity stage was also significant. Oleoresin content was increased as the age of the fruit increased. This is in agreement with Sheela et al. (2001) who reported that oleoresin content was more in red ripe fruits of *C. frutescens* than in mature green fruits. Mini and Vahab (2002) reported that oleoresin recovery was higher in fruits of *Capsicum* spp at withering stage than at red ripe and turning stage. Robi (2003) and Khyadagi (2009) observed the same trend their studies. Oleoresin consists of fixed oil, capsaicin, pigments, sugars and resin and as fruits mature these contents also increase. High pungent oleoresin obtained from CA 7, CA 6 and CA 5 can be used in the pharmaceutical and cosmetic industries where high pungency and high colour are desired. The low pungency oleoresin obtained from CA 28, CA 29 and CA 37 can be of high value in preparation of processed foods making the product more acceptable and pleasing to the eye and for export where low pungency and high colour are desirable traits.

Paprika colourant, which imparts appealing colour, aesthetic flavour and aroma, has many end uses in various food, pharmaceutical and cosmetic preparations. The indiscriminate use of synthetic colours for the food colouring has several harmful effects. This has resulted in huge demand for chilli and paprika oleoresin with high colourant and mild pungency as natural colour. In the present study considerable variation among the genotypes was observed for colour. When fruits were harvested at turning stage (M1) CA 38 recorded maximum colour content in ASTA units (137.06) which was on par with CA 34 (134.67), CA 3 (133.96) and CA 37 (132.50) and CA 5 recorded minimum (60.69). The fruits of CA 2 had maximum colour value (169.21 ASTA units) which was at par with CA 37 (168.37 ASTA units) followed by CA 38 (163.35 ASTA units) when harvested at full ripe stage. CA 20 recorded minimum colour value (79.55 ASTA units) at this stage. When fruits harvested at withering stage CA 37 (200.32 ASTA units) had highest value for colour and was on par with CA 34 (198.48 ASTA units). CA 20 had the lowest content (86.84 ASTA units). Similar to other quality parameters colour value also increased as the age increased and recorded maximum colour value at withering stage. Considering genotypes in relation to maturity stage CA 37 recorded the maximum colour value at withering stage. Similar results were reported by Bini (2004), Prasath et al. (2007), Jyothi et al. (2008) and Srilakshmi (2006) in chilli.

Paprika is an excellent source of Vitamin C. The nutritive value of paprika is largely determined by the content of ascorbic acid. Significant variation in ascorbic acid (mg/100g) among the genotypes was noticed in the current study. At turning stage CA 38 (162.27) had maximum ascorbic acid which was on par with CA 33 (160.37) and CA 22 (160.31). CA 29 (52.72) recorded the lowest ascorbic acid. The fruits of CA 38 (185.07) had highest ascorbic acid content when harvested at full ripe stage and was on par with CA 33 (184.86). The accession CA 1 recorded minimum ascorbic acid content (73.94) at this stage. When fruits harvested at withering stage CA 22 had highest ascorbic acid content (174.86) and CA 1 had the lowest content (67.47). Interaction between genotypes and maturity stages were significant. Ascorbic acid increased from turning stage to red ripe stage and then declined in the withering stage. CA 38 recorded maximum ascorbic acid content (185.07 mg/100g). CA 38, CA 33, CA 34 and CA 35 were found to be excellent sources of ascorbic acid and they are suitable for vegetable purpose. Such wider variation has also been reported by Manju (2001), Bini (2004), Shirsat et al. (2007) and Dandunayak (2008).

Table 1: Mean performance of paprika accessions for oleoresin and colour over maturity stages

Accessions	Oleoresin (%)			Colour (ASTA units)		
	M1	M2	M3	M1	M2	M3
CA 1	8.83	10.83	11.67	116.58	125.93	144.25
CA 2	10.00	10.67	13.14	121.25	169.21	176.41
CA 3	10.00	16.63	20.76	133.96	131.12	153.72
CA 4	8.64	9.67	10.17	65.38	104.73	123.54
CA 5	11.83	15.38	21.13	60.69	84.68	115.00
CA 6	13.20	16.33	20.83	75.16	91.78	110.61
CA 7	12.06	18.09	19.40	99.68	115.38	144.94
CA 8	7.34	8.45	11.17	80.15	103.24	127.63
CA 9	10.62	11.63	14.13	100.96	110.94	142.58
CA 10	8.23	10.83	11.23	93.03	114.39	142.25
CA 11	8.59	12.76	15.46	75.48	90.84	145.16
CA 12	10.56	11.72	19.75	97.44	116.57	146.13
CA 13	8.24	10.03	12.31	85.71	97.92	121.59
CA 14	11.39	13.17	14.67	78.60	105.69	124.63
CA 15	13.83	14.81	17.08	93.40	114.37	130.62
CA 16	12.33	13.67	14.50	101.64	125.64	158.56
CA 17	8.99	12.32	14.22	123.79	149.31	168.91
CA 18	11.83	13.33	14.63	82.76	102.03	117.39
CA 19	10.17	11.17	11.68	104.10	118.68	123.77
CA 20	9.83	10.17	12.00	61.05	79.55	86.84
CA 21	14.82	16.00	18.50	77.02	96.13	119.28
CA 22	9.83	10.83	10.67	77.33	94.75	125.93
CA 23	8.86	9.00	9.83	109.21	123.07	140.69
CA 24	9.01	10.00	10.83	76.77	92.22	104.67
CA 25	15.67	16.17	17.92	69.64	86.91	98.53
CA 26	11.67	13.67	14.77	98.39	111.77	131.81
CA 27	14.97	15.99	16.42	107.12	118.48	146.70
CA 28	14.83	18.00	19.03	101.01	131.89	157.46
CA 29	15.50	17.50	19.10	109.76	125.30	161.30
CA 30	10.19	11.49	13.69	103.49	127.09	147.51
CA 31	9.19	10.00	11.15	88.57	101.37	127.13
CA 32	10.00	10.17	12.20	94.81	114.16	146.59
CA 33	10.17	11.73	13.82	109.22	130.59	161.26
CA 34	8.91	9.98	12.61	134.67	136.45	198.48
CA 35	10.96	14.63	17.80	118.11	137.63	170.58
CA 36	8.17	11.82	15.17	106.41	120.69	162.32
CA 37	12.83	17.00	18.92	132.50	168.37	200.32
CA 38	8.31	10.33	16.45	137.06	163.35	193.60
CA 39	10.66	11.88	13.04	109.28	137.76	157.24
CA 40	10.33	11.53	12.31	104.17	119.18	146.78
CA 41	9.83	11.67	12.15	101.67	114.26	155.17
CA 42	11.20	12.25	14.02	96.17	112.47	139.44
CA 43	10.33	12.18	12.34	111.72	111.48	134.35
CA 44	10.37	13.83	15.16	78.19	96.59	125.40
CA 45	11.33	12.71	14.16	107.71	110.62	117.44
CA 46	10.17	12.28	13.32	99.78	124.17	150.50
CA 47	13.83	14.82	16.17	110.27	144.94	169.18
CA 48	9.73	10.67	11.00	103.08	124.40	142.52
CA 49	10.17	11.17	12.67	100.59	134.50	138.38
CA 50	11.32	13.49	13.89	79.11	95.94	122.12
CA 51	11.83	13.50	14.67	111.54	124.42	135.80
CA 52	12.83	15.00	15.33	118.61	139.65	160.02
CA 53	9.83	10.64	12.67	105.19	137.47	151.09
CD(0.05 values)	0.58			5.15		

Table 2. Mean performance of paprika accessions for ascorbic acid and capsaicin over maturity stages

Accessions	Ascorbic acid (mg/100 g)			Capsaicin (%)		
	M1	M2	M3	M1	M2	M3
CA 1	63.35	73.94	67.47	0.50	0.54	0.58
CA 2	125.33	133.32	126.63	0.62	0.63	0.64
CA 3	74.39	78.61	75.99	0.58	0.57	0.62
CA 4	120.36	124.88	130.08	0.58	0.63	0.64
CA 5	100.00	110.44	116.96	0.66	0.70	0.72
CA 6	122.19	132.02	128.47	0.45	0.52	0.55
CA 7	124.73	140.45	134.92	0.46	0.49	0.60
CA 8	99.21	103.39	101.32	0.38	0.41	0.49
CA 9	117.46	130.66	123.90	0.50	0.51	0.60
CA 10	92.35	106.44	105.24	0.71	0.88	0.99
CA 11	99.66	110.02	108.16	0.36	0.40	0.47
CA 12	104.33	111.04	108.74	0.65	0.73	0.81
CA 13	95.26	101.96	101.23	0.38	0.43	0.54
CA 14	100.30	106.98	103.78	0.35	0.41	0.46
CA 15	100.77	108.60	105.31	0.40	0.46	0.53
CA 16	130.28	136.17	131.79	0.25	0.29	0.35
CA 17	100.20	110.69	103.82	0.15	0.18	0.21
CA 18	114.91	124.58	121.28	0.11	0.11	0.13
CA 19	115.08	124.20	124.86	0.12	0.11	0.14
CA 20	124.65	132.27	146.31	0.15	0.16	0.19
CA 21	113.83	114.53	114.09	0.12	0.12	0.13
CA 22	160.31	175.60	174.86	0.12	0.13	0.13
CA 23	112.52	134.75	129.88	0.14	0.15	0.19
CA 24	113.41	117.71	115.96	0.12	0.14	0.16
CA 25	125.24	130.48	128.41	0.13	0.13	0.17
CA 26	132.35	146.34	146.26	0.14	0.15	0.17
CA 27	99.70	107.41	100.15	0.12	0.15	0.17
CA 28	106.94	85.88	111.50	0.12	0.13	0.14
CA 29	52.72	82.34	75.27	0.16	0.18	0.18
CA 30	100.15	102.10	100.62	0.13	0.18	0.20
CA 31	103.05	120.25	109.24	0.14	0.17	0.17
CA 32	107.65	121.00	114.74	0.12	0.12	0.13
CA 33	160.37	184.86	122.43	0.11	0.13	0.13
CA 34	145.15	174.44	171.56	0.11	0.10	0.10
CA 35	151.85	175.82	168.22	0.11	0.12	0.12
CA 36	139.32	162.95	151.94	0.13	0.13	0.14
CA 37	125.42	155.42	135.26	0.14	0.18	0.23
CA 38	162.27	185.07	168.93	0.08	0.11	0.11
CA 39	148.30	164.00	161.44	0.14	0.17	0.19
CA 40	67.67	88.00	108.40	0.09	0.10	0.15
CA 41	88.03	99.19	100.16	0.11	0.12	0.15
CA 42	117.17	169.25	169.26	0.11	0.12	0.14
CA 43	91.38	125.29	121.67	0.11	0.13	0.17
CA 44	109.26	134.46	131.59	0.11	0.12	0.15
CA 45	77.00	104.22	99.10	0.12	0.13	0.15
CA 46	113.07	133.86	126.42	0.22	0.25	0.25
CA 47	141.32	170.32	162.27	0.10	0.11	0.11
CA 48	101.74	123.17	116.78	0.19	0.19	0.21
CA 49	103.85	129.90	128.00	0.19	0.20	0.20
CA 50	109.94	127.40	123.29	0.18	0.19	0.20
CA 51	108.43	121.16	113.88	0.18	0.20	0.21
CA 52	118.07	129.58	130.67	0.12	0.14	0.16
CA 53	102.83	121.88	117.63	0.16	0.17	0.18
CD (0.05 values)	8.71			0.02		

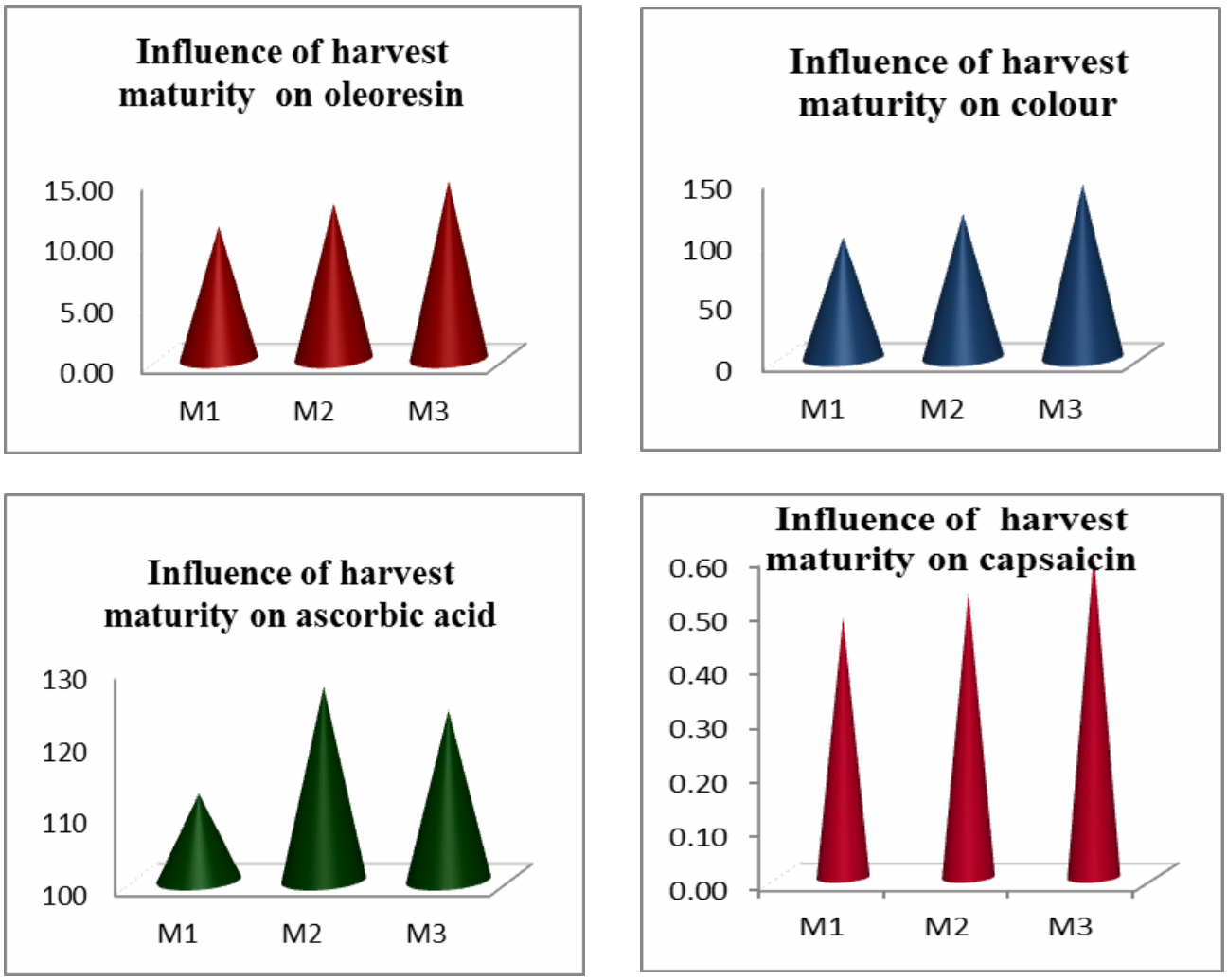

Fig 1: Influence of harvest maturity in different quality characters

Capsaicin, the pungent principle in chilli is considered to be an important quality character. There existed a wide variation among the genotypes for capsaicin content. This variability could be due to the presence of gene modifying factors for pungency, the ratio of placental tissue to seed and pericarp. When fruits were harvested at turning stage (M1) CA 10 recorded maximum capsaicin content (0.71) and CA 38 recorded minimum (0.08%) which was on par with CA 40 (0.09%) and CA 47 (0.10%). At full ripe stage (M2), CA 10 had the highest capsaicin content (0.88%) and CA 34 and CA 40 recorded the lowest capsaicin content of 0.10%. When harvesting was done at withering stage, CA 10 recorded maximum capsaicin content of 0.99% and CA 34 had the lowest capsaicin content (0.10%). Capsaicin content increased as the age of the fruit increased and it was maximum in withering stage among the three different maturity stages. The interaction of genotypes with maturity stage was significant. Considering genotypes in relation to maturity stages, capsaicin was maximum in CA 10 at withering stage and minimum for CA 38 at turning stage.

The present study revealed significant influence of both genotypes and harvest maturity on biochemical parameters of paprika. The fruits left in the plant for withering had high oleoresin, colour and pungency, but low in ascorbic acid (Fig. 1). This indicates the importance of delayed harvest in paprika for oleoresin, colour and capsaicin production. This is relevant with respect to the commercial value of paprika for these characters. The nutritive value depends on ascorbic acid content which is maximum in red ripe stage projecting that the red fruits can be utilized for vegetable purpose for getting more vitamins. These accessions can be included in further paprika improvement programmes according to the end use.

सारांश

फूलगोभी की प्रजाति पूसा स्नोबाल के–1 पर कार्बनिक निवेश तथा जैव समूह के निष्पादन का अध्ययन रैण्डोमाइज्ड ब्लाक डिजाइन में प्रयोगिक प्रक्षेत्र, उद्यान विभाग, आसाम कृषि विश्वविद्यालय जोरहट (आसाम) में वर्ष 2013–2014 में किया गया। प्रयोग में विभिन्न कार्बनिक खादों के स्तरों पर जैव समूहों के साथ एवं एक शोधन संस्तुत उर्वरकों को मिलाकर किया गया। शोधन जिनमें नत्रजन, फास्फोरस व पोटाश के साथ गोबर की खाद (टी1) दिया गया था उसमें सबसे अधिक शीर्ष उपज (280.81 कु./हे.) प्राप्त हुआ तथा इसके बाद जिनमें 5 टन/हे. गोबर की खाद के साथ जैव समूह (टी–8) के प्रयोग से 209.04 कु./हे. उपज प्राप्त हुयी। कार्बनिक खादों में शोधनों में वही शोधन ने उच्चतम मूल्यांकन शीर्ष आकार (103.46 वर्ग सेमी.), पत्ती संख्या (18.73) तथा शीर्ष में राख की मात्रा (6.79 प्रतिशत) रहा। गुणवत्ता घटकों जैसे–एस्कार्बिक एसीड (60.13 मिग्रा./100 ग्राम) सबसे अधिक 5 टन/हे. कम्पोस्ट के साथ जैव समूह (टी–4) में पाया गया। मृदा घटक अध्ययन से स्पष्ट हुआ कि मृदा पी एच मान, मृदा में कार्बनिक पदार्थ की मात्रा, नत्रनज, फास्कोरस, पोटाश एवं जैव समूह की मात्रा समृद्ध कम्पोस्ट की 5 टन/हे. देने व समूह (टी–8) में पाया गया।

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