Chipping quality of potatoes stored in heaps and pits in subtropical plains of India

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ABSTRACT: Two potato cultivars Kufri Bahar and Kufri Jyoti were stored in heaps and pits under ambient conditions of sub-tropical plains of northern India and their chipping quality was determined after 90 days of storage. During storage there was a significant reduction (33.84%) in the reducing sugar content of potatoes and improvement (31.63%) in chip colour. Sugar levels in stored potatoes were within the acceptable limit for processing and table purposes indicating that potatoes stored up to 90 days on the farm in heap and pits are suitable for these two purposes.

Keywords: reducing sugars; chip colour; sucrose; dry matter content; potatoes and storage

The main potato (*Solanum tuberosum* L.) harvest in the Indo-Gangetic plains of India is done during February/March, which is the beginning of a long hot summer. From April to September potatoes are stored in cold stores maintained at 2–4°C and 90–95% RH (Ezekiel et al. 2002). These cold stored potatoes are not suitable for chip making because of 'low temperature sweetening'. Secondly, the rentals for cold storage are charged for six months irrespective of the date of withdrawal from the cold store. The work done at Central Potato Research Institute of India has shown that non-refrigerated storage in heaps and pits can provide a viable option for short-term storage of potatoes (Kaul, Mehta 1999). Heaps and pits are popular in several parts of the country for the following reasons: (*i*) they are cheap, (*ii*) locally available materials are used for the construction of heaps and pits, and (*iii*) they enable the farmer to hold back his produce to sell it later for a better price (Ezekiel et al. 2002). Potato processing in India is increasing steadily, and the Indo-Gangetic plains being the largest potato growing area has to prepare itself for ensuring the supply of the required quantity of raw material. Dogras et al. (1991) reported deterioration in the processing quality of potatoes stored in clamps in Greece and attributed it to the increase in sugar concentration as a result of prevalence of low average temperatures. But in plains of India, average temperatures within clamps/heaps have been reported to be higher than 20°C (Ezekiel et al. 2002; Kaul et al. 2002). The heaps and pits maintain lower temperatures and higher relative humidity as compared to ambient conditions (Paul et al. 2002). The advantage of higher temperatures can therefore be taken for maintaining low reducing sugar levels in potatoes. The present investigation was carried out to determine the chipping quality of potatoes after 90 days of storage in heaps and pits.

MATERIALS AND METHODS

Crops of cvs Kufri Bahar and Kufri Jyoti were raised at Central Potato Research Institute Campus, Modipuram, India (29°04´157´´N, 77°42´450´´E and elevation 237 m above mean sea level) following the recommended package of practices. Planting was done in October and harvesting was done in February. Well-cured potato tubers of the varieties Kufri Bahar and Kufri Jyoti, grown at CPRI farms, were stored in heaps and pits (quantity approx. 1 ton) in the last week of February/first week of March as described by Paul et al. (2002). Studies on the heap storage method were conducted for three years, i.e. from 2001 to 2003, and on the pit method of storage for two years (2002–2003). The pits were of two types: *kutcha* and *pucca*. Two types of pits were similar in dimensions and the only difference was that while the pucca pit was lined with a layer of bricks, the kutcha pit was not. The potato samples were taken at day 0 (zero) and after 90 days of storage from three locations, i.e. top, middle and bottom of heaps and pits. Tubers were then analysed for chip colour, dry

matter content and sugars. For determining the chip colour ten tubers from each replication were washed, hand peeled and cut into 1.75 mm thick slices using an automatic slicer. The slices were washed in normal water to remove surface starch and then the slices were dried on paper towels. The dried slices were fried in sunflower oil at 180°C in a deep fat fryer (Moulinex make) till the bubbling stopped. The fried chips were drained to remove excess oil and then graded from 1 to 10 (1 being the lightest and 10 the darkest, the chip colour grade up to 3 is considered highly acceptable) under the fluorescent tube light using the chip colour cards (Ezekiel et al. 2003). Dry matter content was determined by oven drying finely chopped tuber pieces first at 80°C for six hours and then at 65°C till constant weight. Reducing sugars were quantified following Nelson's (1944) method and sucrose was determined following the proce-

Table 1. Chipping quality of potatoes stored in heaps and pits

Parameter	Mode of storage	Variety	Days of storage		Means
			0	90	
Chip colour	Heap	Kufri Jyoti	4.02	3.12	3.57
		Kufri Bahar	5.39	3.89	4.64
		means	4.71	3.51	4.11
	Kutcha Pit	Kufri Jyoti	4.02	2.65	3.34
		Kufri Bahar	5.39	3.71	4.55
		means	4.71	3.18	3.95
	Pucca Pit	Kufri Jyoti	4.02	2.18	3.10
		Kufri Bahar	5.39	3.80	4.69
		means	4.71	2.99	3.85
Dry matter content (%)	Heap	Kufri Jyoti	19.63	19.01	19.32
		Kufri Bahar	18.63	20.78	19.71
		means	19.13	19.90	19.52
	Kutcha Pit	Kufri Jyoti	19.63	19.21	19.42
		Kufri Bahar	18.63	19.74	19.18
		means	19.13	19.47	19.30
	Pucca Pit	Kufri Jyoti	19.63	19.36	19.50
		Kufri Bahar	18.63	20.09	19.36
		means	19.13	19.72	19.43
Peeling losses (%)	Heap	Kufri Jyoti	7.13	13.51	10.32
		Kufri Bahar	6.96	15.49	11.22
		means	7.05	14.50	10.77
	Kutcha Pit	Kufri Jyoti	7.13	17.44	12.29
		Kufri Bahar	6.96	16.82	11.89
		means	7.05	17.13	12.09
	Pucca Pit	Kufri Jyoti	7.13	14.15	10.64
		Kufri Bahar	6.96	12.65	9.81
		means	7.05	13.40	10.22

LSD values ($P < 0.05$):

	Chip colour	Dry matter content	Peeling losses
Duration (D)	0.25	0.25	0.99
Variety (V)	0.25	0.25	0.99
Mode (M)	0.31	0.30	1.22
D × V	0.35	0.35	1.41
D × M	0.43	0.43	1.72
V × M	0.43	0.43	1.72
D × V × M	0.61	0.60	2.44

dure described by van Handel (1968). The stored potatoes were also tested for browning percentage in a mini potato processing plant by using 2.5 kg sample from each replication as per the procedure reported earlier (Ezekiel et al. 2003). The analysis of variance for results of three years for heaps and two years for pits was computed in randomised block design by using the standard statistical methods in the software IRRISTAT.

RESULTS

The potatoes stored in heaps or pits under sub-tropical environments of central India had chip colour improved after ninety days of storage (Tables 1 and 3). The percentage of brown chips decreased from 64.5% at day zero to 29.41% after ninety days of storage (Tables 2 and 4). An increase in dry matter content was observed and peeling losses also in-

Table 2. Sugar content and brown chip percentage in potatoes stored in heaps and pits

Parameter	Mode of storage	Variety	Days of storage		Means
			0	90	
Reducing sugars (mg/100 g f. wt.)	Heap	Kufri Jyoti	150.05	116.83	133.44
		Kufri Bahar	244.49	151.12	197.81
		means	197.27	133.98	165.62
	Kutcha Pit	Kufri Jyoti	150.05	129.46	139.75
		Kufri Bahar	244.49	138.28	191.39
		means	197.27	133.87	165.57
	Pucca Pit	Kufri Jyoti	150.05	105.07	127.56
		Kufri Bahar	244.49	142.32	193.41
		means	197.27	123.70	160.48
Sucrose (mg/100 g f. wt.)	Heap	Kufri Jyoti	147.73	231.89	189.81
		Kufri Bahar	181.44	340.31	260.87
		means	164.58	286.10	225.34
	Kutcha Pit	Kufri Jyoti	147.73	203.84	175.78
		Kufri Bahar	181.44	245.85	213.64
		means	164.58	224.84	194.71
	Pucca Pit	Kufri Jyoti	147.73	221.74	184.73
		Kufri Bahar	181.44	200.85	190.98
		means	164.58	211.30	187.86
Brown chips (%)	Heap	Kufri Jyoti	41.75	24.36	33.05
		Kufri Bahar	89.50	41.76	65.63
		means	65.63	33.06	49.34
	Kutcha Pit	Kufri Jyoti	41.75	22.67	32.21
		Kufri Bahar	89.50	39.35	64.43
		means	65.63	31.01	47.48
	Pucca Pit	Kufri Jyoti	41.75	15.17	28.46
		Kufri Bahar	89.50	33.17	61.33
		means	65.63	24.17	44.06

LSD values ($P < 0.05$):

	Reducing sugars	Sucrose	Brown chips
Duration (D)	7.30	15.37	2.18
Variety (V)	7.30	15.37	2.18
Mode (M)	8.94	18.82	2.68
D × V	10.32	21.73	3.09
D × M	12.64	26.62	3.78
V × M	12.64	26.62	3.78
D × V × M	17.87	37.64	5.35

creased. The reducing sugar content decreased with the concomitant increase in sucrose content.

Among the three modes of storage, i.e. heap, kutcha pit and pucca pit, minimum chip colour score was obtained in pucca pit while the difference between kutcha pit and heap was insignificant. On the other hand, the differences in the percent brown chip values were insignificant between the three methods of storage. The differences between dry matter content and reducing sugar content were also insignificant. Maximum sucrose accumulation took place in tubers stored under the heap method of storage. The highest value of peeling losses was observed in potatoes stored in kutcha pit (Tables 1 and 2). A decrease of 47.56% in brown chips after storage was observed in Kufri Jyoti while in Kufri Bahar the value was 57.44%. The interaction between variety and duration of storage was significant for browning percentage, highlighting the non-uniform effect of duration on two varieties. The increase in dry matter content was higher in Kufri Bahar tubers as compared to the Kufri Jyoti. The absolute values of all the parameters after 90 days of storage were superior in Kufri Jyoti as compared to Kufri Bahar (Tables 1 and 2).

Table 3. Chipping quality of potatoes stored in heap for three different years

Parameter	Variety	Year	Days of storage		Means
			0	90	
Chip colour	Kufri Jyoti	2001	5.82	4.00	4.91
		2002	4.61	4.30	4.46
		2003	3.44	1.94	2.69
		means	4.62	3.42	4.02
	Kufri Bahar	2001	7.22	6.33	6.78
		2002	5.36	4.32	4.84
		2003	5.42	3.45	4.37
		means	6.00	4.70	5.35
Dry matter content (%)	Kufri Jyoti	2001	18.74	21.03	19.89
		2002	20.25	19.00	19.62
		2003	19.02	19.03	19.03
		means	19.34	19.69	19.51
	Kufri Bahar	2001	19.15	23.08	21.11
		2002	19.92	21.47	20.70
		2003	17.34	20.09	18.72
		means	18.80	21.55	20.18
Peeling losses (%)	Kufri Jyoti	2001	8.19	16.71	12.45
		2002	6.00	14.90	10.45
		2003	8.26	12.13	10.20
		means	7.48	14.58	11.03
	Kufri Bahar	2001	8.85	16.55	12.70
		2002	7.37	18.02	12.70
		2003	6.55	12.95	9.75
		means	7.59	15.84	11.72

LSD values ($P < 0.05$):

	Chip colour	Dry matter content	Peeling losses
Year (Y)	0.34	0.64	1.80
Variety (V)	0.28	0.52	1.47
Duration (D)	0.28	0.52	1.47
Y × D	0.48	0.90	2.55
Y × V	0.48	0.90	2.55
D × V	0.39	0.74	2.08
Y × D × V	0.68	1.27	3.61

The processing quality of potatoes is known to vary considerably from season to season in the same locality and these variations have been attributed to environmental factors (Smith 1987). Since the heap method of storage was studied for three years and year-to-year differences in environmental factors both during pre- and post-harvest period could be expected, the year was also taken as a variant to arrive at more practical conclusions. Significant differences in the mean values of all parameters were observed for different years (Table 3 and 4). But if the interaction between year and duration is taken into consideration, the trends of processing quality changes were same, i.e. reducing sugar content decreased after storage. Even after three years study, the pattern of changes in chipping quality was same as reported for heaps and pits in earlier section.

DISCUSSION

It was possible to take advantage of higher ambient temperatures in the north-central plains of India in the period from potato harvest to the end of June (start of rainy season) for short-term storage of processing grade and table potatoes. In the heap and pit methods of storage, reducing sugar

Table 4. Sugar content & percentage of brown chips in potatoes stored in heap for three different years

Parameter	Variety	Year	Days of storage		Means
			0	90	
Reducing sugars (mg/100 g f. wt.)	Kufri Jyoti	2001	244.15	44.05	144.10
		2002	133.66	87.63	110.65
		2003	166.44	146.02	156.23
		means	181.42	92.57	136.99
	Kufri Bahar	2001	255.69	125.16	190.42
		2002	187.88	156.77	172.33
		2003	301.10	145.47	223.29
		means	248.22	142.47	195.35
Sucrose (mg/100 g f. wt.)	Kufri Jyoti	2001	129.23	330.06	229.64
		2002	140.41	124.09	132.25
		2003	155.05	339.69	247.37
		means	141.56	264.61	203.09
	Kufri Bahar	2001	248.65	854.18	551.42
		2002	172.01	291.51	231.76
		2003	190.86	369.90	280.38
		means	203.84	505.20	354.52
Brown chips (%)	Kufri Jyoti	2001	82.40	20.70	51.55
		2002	56.00	35.33	45.67
		2003	27.50	13.39	20.44
		means	55.30	23.14	39.22
	Kufri Bahar	2001	96.67	90.39	93.53
		2002	87.33	49.33	68.33
		2003	91.67	34.19	62.93
		means	91.89	57.97	74.93

LSD values ($P < 0.05$):

	Reducing sugars	Sucrose	Brown chips
Year (Y)	16.10	33.61	5.38
Variety (V)	13.14	27.44	4.39
Duration (D)	13.14	27.44	4.39
Y × D	22.77	47.53	7.60
Y × V	22.77	47.53	7.60
D × V	18.59	38.81	6.21
Y × D × V	32.19	67.22	10.76

contents decrease and chipping quality improves as clearly shown in this study. Results of similar type were obtained in another geographically and climatically different northwestern region of India (Uppal, Ezekiel 2002). The improvement in chip colour or decrease in browning percentage could be attributed to the decrease in reducing sugar content as reducing sugars are the major component deciding the colour of fried potato products (Roe et al. 1990). Potatoes stored at temperatures up to 20°C were found to have better processing quality (Burton et al. 1992). When potatoes were stored at 7, 16 and 28°C with CIPC treatment, glucose and fructose content (reducing sugars) decreased steadily and at 28°C there was a sharp increase in sucrose content probably due to sprouting (Linnemann et al. 1985). The average temperature in heaps and pits remains above 20°C (Paul et al. 2002) and the decrease in reducing sugar content could be due to losses of sugars due to respiration as well as synthesis of sucrose. The average temperature inside heap was 28.5°C, in kutcha pit 25°C, in pucca pit 25.5°C while the ambient temperature was 39°C. Low activities of invertase or synthesis of invertase inhibitors were also shown to be responsible for reduction in reducing sugar content at higher temperatures of storage (Pressey, Shaw 1966). An increase in sucrose content was observed in both the varieties and in all the three modes of storage after 90 days of storage. The accumulation of sucrose in large quantities in tubers stored at high temperature and in on-farm stores was reported (Uppal 1999; Verma et al. 1974b). After 90 days of storage in heap and pits, the reducing sugar content was lower than the limit of 250 mg/100 g f. wt, considered acceptable for chip making (Ezekiel et al. 1999), and the reducing sugars + sucrose level was much lower than the limit of 1,250 mg/100 g f. wt for table purposes (Es, Hartmans 1987).

As far as year to year variations in processing quality parameters are concerned, the critical analysis of data shows that the chipping quality at the end of storage is decided by the initial values of sugar content, i.e. at the time of storage. If the varieties having lower harvest sugar contents are stored, even yearly variations can be nullified to get acceptable chipping qualities after three months of storage. This has in fact been observed in small-scale preliminary studies with Kufri Chipsona-1 variety specifically bred for chipping (unpublished data). The two varieties included in this study were not bred for processing, but because of the easy availability and cheap prices, small-scale processors use the tubers of these varieties after blanching. The potatoes stored by heap or pit methods, especially of Kufri Jyoti variety, could be used by small-scale processors for making good quality chips without blanching.

The increase in dry matter observed after storage was mainly caused by moisture loss through evaporation (Verma et al. 1974b). The relative humidity remains low in both heap and pit methods of storage (50–60%). The higher values of peeling losses can also be attributed to relatively lower relative humidity conditions in these types of storage. Whenever the weight loss exceeds 10%, the tubers become shrivelled (Booth, Shaw 1981), resulting in difficult peeling of potatoes. The physiological losses in heap and pit methods of storage are in the range of 7 to 13%, and sprouting accounts for a maximum portion of losses because of higher water losses from sprouts (Paul et al. 2002). Burton (1992) calculated that the epidermis of the sprouts is about 100 times as permeable to water as the surface of the tuber. Sprout growth corresponding to a 10% increase in the tuber area causes an increase of 100% in moisture loss. Sprouting losses for Kufri Jyoti and Kufri Bahar were 0.4% and 2.3% in heaps, 0.6% and 1.4% in kutcha pit and 0.4% and 1.3% in pucca pit, respectively. The relatively higher increase in dry matter content in Kufri Bahar tubers as compared to Kufri Jyoti could be attributed to higher sprouting losses in Kufri Bahar (Paul et al. 2002). Sukumaran et al. (1981) stated that chemical sprout control should be a component of any strategy for even short-term non-refrigerated storage of potatoes. Bailey et al. (1978) reported an increase in reducing sugars with sprouting. If sprout control measures are also included in heap and pit storage methods, the peeling losses will come down, physiological losses will be low and the sugar contents could be brought down further, making potatoes more acceptable for chipping. Peeling losses increased, but no difficulty was observed in peeling by an abrasive peeler, hence potatoes were quite suitable for chip making.

Though the quality of potatoes stored in Pucca pit was found to be the best, because of the cost involved and permanent sacrifice of a piece of land, heap storage could be a more viable method of storage. This could be possible if alterations with respect to better sprout control and storage of special chipping varieties are explored.

People in northern India do not like the cold stored (2–4°C) potatoes for ware purposes or for making processed products because of sweet taste, and pay a premium price for low sugar potatoes. The heap or pit stored potatoes are very suitable to satisfy the needs of ware potato consumers also as evident from low total sugar contents.

Thus, potatoes stored on the farm in heaps and pits are very suitable for chipping and also for ware

purposes unlike cold stored potatoes, and could fetch a premium price to grower with minimum investments.

CONCLUSIONS

The potatoes stored in heap or pits become suitable for processing and also for ware purposes, because of low reducing sugar contents resulting from higher temperatures after harvest.

Pucca pit is the best of the three tested methods with respect to processing quality, but heap can be a preferred choice because of its easy construction and minimum investments.

Use of low sugar genotypes and sprout control could further improve the quality of potatoes and increase returns to growers by storing potatoes according to these methods.

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References

BAILEY K.M., PHILLIPS P.J., PITT D., 1978. The role of buds and gibberellin dormancy and the mobilization of reserve materials in potato tubers. Annals of Botany, *42*: 649–657.

BOOTH R.H., SHAW R.L., 1981. Principles of potato storage. International Potato Center, Lima.

BURTON W.G., ES A. VAN, HARTMANS K.J., 1992. The physics and physiology of potato storage. In: HARRIS P.M. (eds.), The Potato Crop. London, Chapman and Hall: 610–629.

DOGRAS C., SIOMOS A., PSOMAKELIS C., 1991. Sugar and dry matter changes in potatoes stored in a clamp in a mountainous region of Northern Greece. Potato Research, *34*: 211–214.

ES A. VAN, HARTMANS K.J., 1987. Sugars and starch during tuberization, storage and sprouting. In: RASTOVSKI A. et al. (eds.), Storage of Potatoes. Wageningen, Pudoc: 82–98.

EZEKIEL R., VERMA S.C., SUKUMARAN N.P., SHEKHAWAT G.S., 1999. A guide to potato processors in India. Technical Bulletin *49*. Central Potato Research Institute, Shimla.

EZEKIEL R., DAHIYA P.S., SHEKHAWAT G.S., 2002. Traditional methods of potato storage in the Malwa region of Madhya Pradesh. Technical Bulletin *57*. Central Potato Research Institute, Shimla.

EZEKIEL R., SINGH B., KUMAR D., 2003. A reference chart for potato chip colour for use in India. Journal of Indian Potato Association, *30*: 259–265.

KAUL H.N., MEHTA A., 1999. Storage of potatoes in India. Technical Bulletin *47*. Central Potato Research Institute, Shimla.

KAUL H.N., MEHTA A., EZEKIEL R., 2002. Storability of potatoes in pits and heaps – a feasibility study. In: KHURANA S., PAUL M. et al. (eds.), Potato, Global Research and Development – Vol. II. Shimla, IPA: 1086–1090.

LINNEMANN A.R., ES A. VAN, HARTMANS K.J., 1985. Changes in the content of L-ascorbic acid, glucose, fructose, sucrose and total glycoalkaloids in potato (Cv. Bintje), stored at 7, 16 and 28°C. Potato Research, *28*: 271–278.

NELSON N.A., 1944. A photometric adaptation of the Somogyi method for the determination of glucose. Journal of Biological Chemistry, *153*: 375–380.

PAUL V., EZEKIEL R., SINGH J., SHEKHAWAT G.S., 2002. Evaluation of on-farm storage methods of potato in Indo-Gangetic plains. In: KHURANA S., PAUL M. et al. (eds.), Potato Global Research and Development – Vol. II. Shimla, IPA: 1080–1085.

PRESSEY R., SHAW R., 1966. Effect of temperature on invertase: intertase inhibitor and sugars in potato tubers. Plant Physiology, *41*: 1657–1661.

ROE M.A., FAULKS R.M., BELSTEIN J.L., 1990. Role of reducing sugars and amino acids in fry colour of chips from potatoes under different nitrogen regions. Journal of Science of Food and Agriculture, *52*: 207–214.

SMITH O., 1987. Effect of cultural and environmental conditions on potato processing. In: TALBURT W.F., SMITH O. (eds.), Potato Processing. New York, Vand Nostrand Reinhold Company: 73–147.

SUKUMARAN N.P., KAUL H.N., PERUMAL N.K., SINGH L., JASSAL J.S., 1981. The use of maleic hydrazide as a sprout suppressant for nonrefrigerated storage of potatoes. In: KISHORE H. (ed.), Post-harvest technology and utilization of potato. Proceedings of International Symposium, Shimla-New Delhi, 1979. New Delhi, CIP: 359–365.

UPPAL D.S., 1999. Effect of storage environments on chip color and sugar levels in tubers of potato cultivars. Journal of Food Science Technology, *36*: 545–547.

UPPAL D.S., EZEKIEL R., 2002. Effect of traditional storage methods on sugar concentrations and chip quality of potatoes. In: KHURANA S., PAUL M. et al. (eds.), Potato, Global Research and Development – Vol. II. Shimla, IPA: 1091–1095.

VAN HANDEL E., 1968. Direct micro-determination of sucrose. Analytical Biochemistry, *22*: 280–83.

VERMA S.C., SHARMA T.R., VERMA S.M., 1974a. Effect of extended high temperature storage on weight losses and sugar content of potato tuber. Indian Journal of Agricultural Sciences, *44*: 702–706.

VERMA S.C., SHARMA T.R., VERMA S.M., 1974b. Sucrose accumulation during high temperature storage of potato tubers. Potato Research, *17*: 224–226.

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Kvalita hlíz bramboru na výrobu lupínků skladovaných v povrchových a zemních krechtech subtropických nížin Indie

ABSTRAKT: Hlízy dvou odrů bramboru Kufri Bahar a Kufri Jyoti byly skladovány v povrchových a zemních krechtech v podmínkách subtropických nížin severní Indie a po 90 dnech skladování se hodnotila jejich kvalita pro výrobu smažených bramborových lupínků. V průběhu skladování došlo v hlízách obou odrůd k průkaznému snížení obsahu redukujících cukrů a ke zlepšení barvy lupínků. Hladina cukrů se ve skladovaných hlízách pohybovala v rozmezí hodnot přijatelných pro potravinářské zpracování i ke stolním účelům. To ukazuje, že hlízy skladované až 90 dnů v povrchových a zemních krechtech jsou pro oba účely vhodné.

Klíčová slova: redukující cukry; barva lupínků; sacharóza; obsah sušiny; brambory; skladování

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