

## Varietal response to Sauerkraut preparation

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### ABSTRACT

Fresh mature heads of six varieties of cabbage viz., Mohar-2, Fast Ball, Shaan, Royal Stone, Red Cabbage and Early Desi cabbage were chopped in small pieces and mixed with 2.5% salt concentration and allowed to ferment at ambient condition and quality of each variety was assessed. There exists significant variation of quality parameters among the varieties of fresh cabbage. pH of Fast Ball remained maximum throughout the period of fermentation from 7<sup>th</sup> day to 28<sup>th</sup> day while sauerkraut prepared out of Shaan was found to be least throughout the period of fermentation. Total soluble solids of Red cabbage remained higher throughout the fermentation period. Acidity and lactic acid of fermented sauerkraut of all the varieties increased up to 21 day of fermentation and thereafter it decreased marginally. The acidity and lactic acid of Shaan was high and reached a maximum of 2.00 and 2.82 per cent respectively on 21<sup>st</sup> day. This was followed by Mohar-2, Royal Stone, Fast Ball, Red Cabbage and Early Desi Cabbage. On 28<sup>th</sup> day highest acidity and lactic acid of 1.89 and 2.66 per cent respectively was observed in Shaan while least acidity and lactic acid of 1.34 and 1.89 per cent was noted in Early Desi cabbage. Ascorbic acid content on 7<sup>th</sup> day was significantly high in varieties Shaan and Royal stone while low ascorbic acid was recorded in Red cabbage and Early Desi cabbage. It increased gradually in all the varieties up to 21 days except in Red cabbage and thereafter it declined. On 28<sup>th</sup> day maximum ascorbic acid was observed in Shaan and minimum in Early Desi cabbage. Sensory score for colour, texture, flavour and overall acceptability remained maximum in Shaan throughout the period of fermentation. Thus Shaan was found to be most suitable for sauerkraut preparation among the varieties studies because of attaining high acidity and lactic acid within 21 day of fermentation and obtaining appropriate level of pH, TSS and possessing high ascorbic acid in the fermented product.

**Keywords:** Cabbage, varieties, fermentation, sauerkraut

Cabbage (*Brassica oleracea* L. var. capitata) is a good source of vitamin B and C, carotene and minerals. India is the second largest producer of cabbage in the world while West Bengal ranked first in production as well as consumption among Indian states (De and Rahman, 2014). About 20-40 per cent of the produce is lost after harvest due to improper post harvest handling and preservation (Thakur and Kabir, 2015). Sauerkraut is an acidic cabbage which results from natural fermentation by bacteria indigenous to cabbage in the presence of salt. In sauerkraut, fermentation of cabbage yield lactic acid as the major product. This lactic acid along with other minor products of fermentation, gives sauerkraut its characteristic flavour and texture (Keith, 1996).

Commercial product of quality sauerkraut depends upon cabbage variety (Mikki and Anand, 1974, Wood, 1998, Lakshmana and Rajanna, 2002). Mild flavour, sweet white cabbage is sought because it make superior product, other desirable traits are large dense head (3.5 to 5.5kg) with minimum green outer leaves. Lakshmana and Rajanna (2002) have given emphasis on selection of suitable variety/hybrid to obtain good quality sauerkraut. They prepared sauerkraut from different F<sub>1</sub> hybrid of cabbage mainly Super Hero, Maharani, Harirani Shristi and Rajrani and found that Maharani hybrid was superior with regard to quality of sauerkraut. Red

cabbage was reported to equally good with respect to Pusa Drumhead (Mikki and Anand, 1974). Dobricevic *et al.*, (2007) from Croatia tested 16 to 23 cultivars and found that fresh cabbage quality has a strong influence on fermentation and storage life of sauerkraut. The present investigation was thus carried out to assess the suitability of currently cultivated varieties in this region for sauerkraut preparation.

### MATERIALS AND METHODS

The experimental material comprised of five hybrids and one local variety: Mohar-2: (Bharat Nursery Pvt. Ltd.), Fast Ball: (Nunhems India Pvt. Ltd.), Shaan: (Known You Seed India Pvt. Ltd.), Royal Stone: (Nunhems India Pvt. Ltd), Red cabbage (Primer F1) (Bejo, bejoZadenb.v. Pvt. Ltd) and Early Desi (Locality collected).

The crop was raised in the Incheck Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal. Preparation of Sauerkraut, storage study and analytical work was conducted in the laboratory of the Department of Post Harvest Technology of Horticultural Corps, Mohanpur in the year 2012-13 and 2013-14.

Fresh, mature cabbage head of different varieties were harvested from middle of February onwards and brought to laboratory. Observation of physical characters, pH, TSS (°Brix), Acidity (%) Lactic acid (%),

Ascorbic acid (mg per 100g) and total sugar (%) of freshly harvested cabbage was recorded. For sauerkraut preparation about 500gram of fresh cabbage head were chopped in small pieces of 4 x 2 mm size. Salt (non-iodized NaCl) concentration at the rate of 2.5 per cent (on base sample weight) were mixed with the chopped cabbage and put in 2 liter beaker and sealed air tight with plastic. The preparation sample was kept for 21 days for complete fermentation as reported earlier by Thakur and Kabir (2015) and the prepared sauerkraut was stored at ambient condition (16°C to 29°C).

After preparation of sauerkraut, the sample was analysed for pH, TSS (°Brix), titratable acidity (%), lactic acid (%), ascorbic acid (mg per 100g), total sugar (%) and sensory score was recorded at 7 days interval. Titratable acidity, ascorbic acid and total sugar was estimated according to Ranganna (2000). Lactic acid was determined following the method of Cappuccino, *et al.*, (1996)

Sensory score for appearance, colour, texture, flavour and overall acceptability were recorded following 10 point hedonic scale. Where 1 to 4.5 refers as poor quality, 4.5 to 6.5 as fair, 6.5 to 8 as good and 8 to 10 as excellent taste quality was used in the evaluation (Lakshmana *et al.*, 2002). The taste panel of the 10 persons used in this study was trained by a professional specialist in sensory evaluation for carrying out different sensory evaluation tasks. Each varietal treatment of sauerkraut was replicated four times with completely randomized design.

## RESULTS AND DISCUSSION

The physical and chemical characters of the cabbage varieties are presented in table 1. Of the six varieties the colour of head of Mohar-2 and Shaan is deep green; Fast ball, Royal Stone and Early Desi is light green and Red cabbage is deep red. The shape of head of Fast Ball, Shaan, Royal Stone, Red cabbage and Early Desi cabbage is round while shape of Mohar-2 is oval. There exists significant difference among the varieties for different chemical quality characteristics (Table 1). The pH of Mohar-2 (3.96) and Fast Ball (3.91) was significantly lower than Shaan (6.10), Royal Stone (5.80), Red cabbage (5.62) and Early Desi cabbage (7.76). Mohar-2 possess overall high TSS (5.50p Brix), acidity (0.45%) and lactic acid (0.63%) content. The TSS content of Fast Ball is high (5.75p Brix) but acidity (0.28%) and lactic acid (0.39%) was low. The TSS of Shaan (3.5p Brix), Royal Stone (2.8p Brix) and Red cabbage (3.2p Brix) was low while acidity and lactic acid of Shaan (0.32% and 0.45%), Royal Stone (0.40% and 0.57%) and Red cabbage (0.32% and 0.45%) were moderate. Early Desi cabbage possessed moderate

amount of TSS (4.6p Brix) and least acidity (0.16%) and lactic acid content (0.23%). The estimated ascorbic acid was significantly high in Royal stone (30.45 mg per 100g) and Shaan (29.40 mg per 100g) compared to Red Cabbage (20.80 mg per 100g), Mohar-2 (19.29 mg per 100g), Early Desi cabbage (18.48 mg per 100g) and Fast Ball (16.95 mg per 100g). Total sugar content was observed to be maximum in Fast Ball (2.07%) followed by Early Desi cabbage (2.06%), Shaan (1.63%), Royal Stone (1.50%), Red cabbage (1.46%) and Mohar-2 (1.37%) in that decreasing order.

Table 2 showed that pH of Fast Ball remained maximum throughout the period of fermentation from 7<sup>th</sup> day to 28<sup>th</sup> day while sauerkraut prepared out of Shaan was found to be least throughout the period of fermentation. On 28<sup>th</sup> day, pH of Fast Ball was 3.71 followed by 3.59 in Mohar-2, 3.57 in Red cabbage, 3.52 in Royal Stone and Early Desi cabbage and 3.38 in Shaan. Total soluble solids of Red cabbage remained high throughout the fermentation period *i.e* on 7<sup>th</sup> day (8.5%), 14<sup>th</sup> day (9.6%), 21<sup>st</sup> day (9.6%) and 28<sup>th</sup> day (9.4%) of fermentation (Table 2). TSS was least in sauerkraut prepared from Royal Stone on 7<sup>th</sup> day (6.2%), Shaan on 14<sup>th</sup> day (6.2%), both Fast Ball and Shaan on 21<sup>st</sup> day (7.2) and both Fast Ball and Royal Stone on 28<sup>th</sup> day (6.8%)

Acidity and lactic acid content of the fermented sauerkraut of all the varieties increased up to 21<sup>st</sup> day of fermentation and thereafter it decreased marginally (Table 3). The acidity and lactic acid of Shaan was high and reached a maximum of 2.00 and 2.82 per cent respectively on 21<sup>st</sup> day. This was followed by Mohar-2 (with 1.72% acidity and 2.43% lactic acid), Royal Stone (with 1.72% acidity and 2.43% lactic acid), Fast Ball (with 1.68% acidity and 2.37% lactic acid), Red cabbage (with 1.59% acidity and 2.25% lactic acid) and Early Desi cabbage (with 1.49% acidity and 2.10% lactic acid) on 21<sup>st</sup> day of fermentation. On 28<sup>th</sup> day highest acidity and lactic acid of 1.89% and 2.66% respectively observed in Shaan while least acidity and lactic acid of 1.34 and 1.89 per cent respectively was noted in Early Desi cabbage.

Ascorbic acid content on 7<sup>th</sup> day was significantly high in varieties Shaan (33.93mg per 100g) and Royal Stone (31.59mg per 100g) while low ascorbic acid was recorded in Red cabbage (10.21mg per 100g) and Early Desi cabbage (15.84mg per 100g). It increased gradually in all the varieties up to 21<sup>st</sup> day except in Red cabbage and thereafter it declined. On 21<sup>st</sup> day maximum ascorbic acid content of 64.13% was observed in variety Shaan followed by Royal Stone (52.03mg per 100g), Mohar-2 (49.40mgper 100g), Fast Ball (46.80mg per 100g) and Early Desi Cabbage (20.41mg per 100g). In Red

**Table 1: Physical and chemical quality of fresh cabbages varieties**

Varieties	Physical characters of cabbage	pH	TSS (°Brix)	Acidity (%)	Lactic acid (mg per 100g)	Ascorbic acid (%)	Total Sugar
Mohar-2	Head is deep green in color and oval in shape	3.96	5.50	0.45	0.63	19.29	1.37
Fast Ball	Head is light green in color and round in shape	3.91	5.75	0.28	0.39	16.95	2.07
Shaan	Head is deep green in color and round in shape	6.10	3.5	0.32	0.45	29.40	1.63
Royal Stone	Head is light green in color and round in shape	5.80	2.8	0.40	0.57	30.45	1.50
Red cabbage	Head is deep red in color and round in shape	5.62	3.2	0.32	0.45	20.80	1.46
Early Desi cabbage	Head is light green in color and round in shape	7.76	4.6	0.16	0.23	18.48	2.06
<b>SEm(±)</b>		<b>0.043</b>	<b>0.133</b>	<b>0.024</b>	<b>0.024</b>	<b>0.758</b>	<b>0.259</b>
<b>LSD(0.05)</b>		<b>0.132</b>	<b>0.411</b>	<b>0.075</b>	<b>0.075</b>	<b>2.335</b>	<b>0.798</b>

**Table 2: Influence of cabbage varieties on pH and TSS of sauerkraut at 7 days interval**

Varieties	pH				TSS (°Brix)			
	Days							
	7	14	21	28	7	14	21	28
Mohar-2	3.80	3.73	3.42	3.59	7.6	7.6	7.8	7.6
Fast Ball	3.83	3.69	3.55	3.71	7.8	7.2	7.2	6.8
Shaan	3.51	3.45	3.37	3.38	7.0	6.2	7.2	7.2
Royal Stone	3.69	3.65	3.55	3.52	6.2	6.4	7.4	6.8
Red cabbage	3.77	3.62	3.51	3.57	8.5	9.6	9.6	9.4
Early Desi cabbage	3.79	3.56	3.45	3.52	7.2	8.6	8.6	8.4
<b>SEm(±)</b>	<b>0.044</b>	<b>0.037</b>	<b>0.027</b>	<b>0.032</b>	<b>0.144</b>	<b>0.150</b>	<b>0.175</b>	<b>0.144</b>
<b>LSD(0.05)</b>	<b>0.135</b>	<b>0.115</b>	<b>0.084</b>	<b>0.099</b>	<b>0.444</b>	<b>0.462</b>	<b>0.539</b>	<b>0.446</b>

**Table 3: Influence of cabbage varieties on Acidity and Lactic acid of Sauerkraut at 7 days interval**

Varieties	Acidity (%)				Lactic acid (%)			
	Days							
	7	14	21	28	7	14	21	28
Mohar-2	0.95	1.34	1.72	1.59	1.35	1.89	2.43	2.25
Fast Ball	0.85	1.21	1.68	1.64	1.20	1.71	2.37	2.32
Shaan	1.27	1.58	2.00	1.89	1.80	2.23	2.82	2.66
Royal Stone	0.93	1.43	1.72	1.57	1.31	2.01	2.43	2.21
Red cabbage	0.69	0.95	1.59	1.46	0.99	1.35	2.25	2.07
Early Desi cabbage	0.92	1.05	1.49	1.34	1.29	1.49	2.10	1.89
<b>SEm(±)</b>	<b>0.027</b>	<b>0.045</b>	<b>0.219</b>	<b>0.027</b>	<b>0.038</b>	<b>0.063</b>	<b>0.037</b>	<b>0.038</b>
<b>LSD(0.05)</b>	<b>0.085</b>	<b>0.141</b>	<b>0.676</b>	<b>0.084</b>	<b>0.117</b>	<b>0.196</b>	<b>0.116</b>	<b>0.118</b>

**Table 4: Influence of cabbage varieties on Ascorbic acid of sauerkraut at 7 days interval**

Varieties	Ascorbic acid (mg per100g)			
	Days			
	7	14	21	28
Mohar-2	22.87	36.03	49.40	32.12
Fast Ball	27.26	30.52	46.80	38.28
Shaan	33.93	43.65	64.13	45.63
Royal Stone	31.59	43.65	52.03	44.46
Red cabbage	10.21	37.44	36.10	45.61
Early Desi cabbage	15.84	17.17	20.41	17.10
<b>SEm(±)</b>	<b>0.526</b>	<b>0.736</b>	<b>1.565</b>	<b>0.662</b>
<b>LSD(0.05)</b>	<b>1.620</b>	<b>2.270</b>	<b>4.822</b>	<b>2.041</b>

**Table 5. Influence of cabbage varieties on sensory qualities of sauerkraut at 7 days interval**

Varieties	Colour				Texture				Flavour				Acceptability			
	Days				Days				Days				Days			
	7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28
Mohar-2	7.00	6.33	5.83	4.83	7.83	7.50	6.50	5.33	7.17	6.67	5.50	4.67	7.67	7.33	6.17	5.67
Fast Ball	7.33	6.00	5.83	5.17	7.83	7.33	6.33	5.17	7.33	6.50	5.67	5.50	7.33	7.33	6.00	5.00
Shaan	7.50	6.50	6.33	6.17	8.00	7.50	6.83	6.50	7.67	6.83	6.33	5.67	8.00	7.67	6.67	6.00
Royal Stone	7.00	5.67	5.50	4.67	7.33	6.17	6.17	5.17	7.00	5.67	5.00	4.50	7.17	7.00	5.67	4.83
Red cabbage	7.33	6.67	5.33	4.67	7.50	6.17	6.00	5.33	7.17	6.00	5.00	4.50	7.17	7.00	5.50	4.67
Early Desi cabbage	7.50	6.33	5.00	4.33	7.17	6.00	5.50	4.83	6.83	5.50	4.67	4.33	7.33	7.17	5.33	4.50
<b>SEm(±)</b>	<b>0.415</b>	<b>0.426</b>	<b>0.319</b>	<b>0.392</b>	<b>0.487</b>	<b>0.437</b>	<b>0.468</b>	<b>0.328</b>	<b>0.426</b>	<b>0.691</b>	<b>0.299</b>	<b>0.334</b>	<b>0.190</b>	<b>0.210</b>	<b>0.329</b>	<b>0.325</b>
<b>LSD(0.05)</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>												

cabbage, ascorbic acid content increased abruptly to 37.44mg per 100g on 14<sup>th</sup> day than it slightly decreased to 36.10mg per 100g on 21<sup>st</sup> day and thereafter it increased to 45.61mg per 100g on 28<sup>th</sup> day. On 28<sup>th</sup> day maximum ascorbic acid was observed in Shaan (45.63mg per 100g) and minimum ascorbic acid was recorded in Early Desi cabbage (17.10mg per 100g)

The sensory quality revealed no significant difference among the varieties with regard to colour, texture, flavour and overall acceptability during sauerkraut preparation at different interval. In generally it was found that colour, texture, flavour and overall acceptability decreased with the increase of fermentation period. Sensory score for colour was maximum in Shaan throughout the fermentation period up to 28<sup>th</sup> days. On 28<sup>th</sup> day the sensory score for colour of Shaan was 6.17 followed by Fast Ball (5.17) and Mohar-2 (4.83) and lowest in Early Desi cabbage (4.33). Sensory score of Shaan for texture also remained high throughout the period of fermentation. On 28<sup>th</sup> day sensory score of texture Shaan

was highest (6.50) while that of Early Desi cabbage was lowest (4.83). Similarly regarding flavour also sensory score of Shaan was high during the fermentation while that of Red cabbage remained least throughout the period of fermentation. Overall acceptability also showed the superiority of Shaan as indicated by 6.67 and 6.00 i.e. good sensory score on 21<sup>st</sup> day and 28<sup>th</sup> day of fermentation compared to other varieties. Early Desi cabbage exhibited least sensory score of 5.33 and 4.50 on 21<sup>st</sup> day and 28<sup>th</sup> day of fermentation.

The results indicated that the pH decreased continuously up to 21<sup>st</sup> day of fermentation in all the varieties and then it increased marginally on 28<sup>th</sup> day. TSS of all the varieties decreased initially and then it increased slightly in the later part of fermentation except in Fast Ball. But the acidity and lactic acid on the other hand increased continuously upto 21<sup>st</sup> day in all the varieties and then it decreased on 28<sup>th</sup> day. This shows that fermentation process was complete on 21<sup>st</sup> day in all the varieties (Mohar-2, Fast Ball, Shaan, Royal Stone,

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Red Cabbage and Early Desi cabbage). However maximum acidity of 2.00% and lactic acid of 2.82% of cultivar Shaan on 21<sup>st</sup> day in the present investigation are an indication of completion of fermentation process and the results are in conformity with the previous report by Chauhan *et al.*, (2008)

The increase in pH, TSS, acidity and lactic acid percentage in sauerkraut during the fermentation process, may be due to activity of lactic acid bacteria (Jones, 1975). Ascorbic acid was estimated to be highest (64.13mg per100g) in Shaan on 21<sup>st</sup> day of fermentation i.e. on completion of fermentation. This might be due to the high concentration of initial ascorbic acid content in the cabbage head (Lakshmana and Rajanna. 2002). Sensory score also confirmed the superiority of Shaan. Royal Stone having high initial ascorbic acid content (30.45mg per100g) also possessed high ascorbic acid content (52.03mg per 100g) on 21<sup>st</sup> day of fermentation. Improvement of ascorbic acid in sauerkraut has also been reported earlier by Srivastava, (2008).

The influence of variety on quality of sauerkraut production has been reported earlier (Mikki and Anand, 1974, Wood, 1998, Lakshmana and Rajanna, 2002 and Dobricevic *et al.*, 2007). This might be due to difference of initial physical and chemical composition of varieties. Further, texture of leaves of variety and thickness of shred also influence the sauerkraut production (Srivastava, 2008). In the present investigation Shaan having pH and ascorbic acid values similar to the cultivars evaluated by Dobricevic *et al.*, (2007) responded better to fermentation for quality product. Total sugar level for lactic acid fermentation was however lower in Shaan compared to requirement according to previous report (FAO, 1997). Higher lactic acid in Shaan compared to the report of Dobricevic *et al.*, (2007) might be due to different fermentation condition apart from genotypic differences. Thus Shaan is most suitable for sauerkraut preparation among the varieties studied.

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