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Effect of salt concentration on the quality of sauerkraut

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ABSTRACT

Investigation was carried out to assess the effect of salt concentration on the quality of sauerkraut prepared from mature cabbage head. To prepare the sauerkraut, cabbage sample were chopped in small pieces and mixed with different salt concentrations i.e., 2.0, 2.5, 3.0, 3.5 and 4.0 % and allowed to ferment at ambient condition. Acidity of sauerkraut was increased with increase in fermentation period reaching maximum at 21 days after fermentation, which thereafter decreased in all the salt treated samples except with 2% salt concentration where maximum acidity was recorded on 28 days. The sample with 2.5% salt treatment obtained desirable acidity of around 2.0% on 21 days of fermentation. Further, sauerkraut with 2.5% salt possessed maximum lactic acid, ascorbic acid content, desirable pH and TSS as compared to other salt concentrations. It also rated the highest score of overall sensory quality.

Keywords : Cabbage, fermentation, quality, salt concentration, sauerkraut

Cabbage (*Brassica oleracea*) is a good source of vitamin B and C, carotene and minerals, used either as raw salad or cooked vegetable in India (Panday *et al.,* 2006). 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). However, about 20-40% of the produce is lost after harvest due to improper postharvest handling and preservation. Sauerkraut is an important fermented product of cabbage and is a mean of preserving cabbage in an inexpensive, bulk storage for prolonged period. It is a low-calorie food and ascorbic and other nutrients are preserved and desirable sensory properties are created by a proper fermentation (Trail *et al*., 1995). It is an acidic cabbage, which results from natural fermentation by bacteria indigenous to cabbage in the presence of salt. It is highly popular in some countries of Europe and in the USA. Sauerkraut as a fermented product is important in countries like India also where other commercial processing methods are expensive and less available. Sauerkraut may store well under a wide variety of conditions. The addition of salt is one of the critical point in sauerkraut production because of the type and extent of microbial growth and the sensory properties of the final product are affected by the amount of salt used (Holzapfed *et al*., 2003). Further consumers nowadays prefer to lower their sodium intake, which has led to research work aimed at lowering and partially replacing NaCl in foods (Viander *et al*., 2003). Thus in the present experiment, the effect of different salt concentrations on the quality of sauerkraut at different stage of preparation was investigated to determine appropriate dose of salt.

MATERIALS AND METHODS

The experiment was carried out with freshly harvested green cabbage in the laboratory of Post Harvest Technology of Horticultural Crops, Faculty of Horticulture, BCKV during the month of November and December 2011. Different salt (non iodized NaCl) viz., T_1 = 2 % , T_2 = 2.5% , T_3 = 3% , T_4 = 3.5% and T_5 = 4% were taken for the preparation of sauerkraut. About 500 gram of fresh cabbage head after removing the outer leaves and inner core were chopped in small pieces of 4 × 2 mm size. Salt concentrations at different percent (on basis sample weight) were mixed with the chopped cabbage and placed in 2 liters beaker and sealed air tight with plastic. Each sample was replicated for four times. The prepared sauerkraut samples were kept in ambient temperature (18-25^{0}C) for fermentation. Sensory evaluation and chemical analysis for pH, total soluble solids, titratable acidity , lactic acid and ascorbic acid were made at 7 days interval. Sensory evaluation for colour, texture, odour and overall acceptability were judged by 10-point scale . The chemical analysis of sauerkraut were done by using the method suggested by Ranganna (2000). The experiment was laid out in completely randomized design.

RESULTS AND DISCUSSION

Table 1, showed significant differences among salt concentration on pH and TSS at different days interval. On 7th day of fermentation pH of T_1 (2%) and T_2 (2.5%) was 3.6 and it increased with increased concentration of salt (*i.e.,* 3.65 for 3%, 3.72 for 3.5% and 3.74% for 4.0%). The pH however decreased with increased fermentation period and on 21th day the pH of T_2 (2.5%) was least (3.5) followed by T_1 (with pH 3.54), T_3 (with pH 3.54), T_4 (with pH 3.55) and T_5 (with pH 3.60) in that increasing order. On 28 day pH of T_1 and T_3 decreased further while pH of T_2 remained same and that of T_4 and T_5 increased marginally. TSS of all the treatment increased up to 21 day of fermentation. On 21 day, TSS was 7.8 in 2% salt (T_1) and TSS increased with the

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increase in salt concentration. However, on 28th day TSS reduced in all the treatments.

The effect of salt concentration on acidity and lactic acid of sauerkraut has been presented in the table 2. Acidity of sample was increased moderately with increase in fermented period, but decreased with increase in percentage of salt concentration up to 14th day of fermentation. On 21st day and 28th day acidity increased with increase in salt concentration from 2% to 2.5% and thereafter it gradually decreased with increase in salt concentration. Sauerkraut of 2.5% salt (T_2) concentration took 21 days to obtain maximum acidity

Table 1: Effect of salt concentration on pH and TSS of Sauerkraut at different days intervals

	pH				TSS (°Brix)			
Salt %	**7day**	**14 day**	**21 day**	**28 day**	**7day**	**14 day**	**21 day**	**28 day**
T_1 (2%)	3.60	3.58	3.54	3.52	7.4	7.6	7.8	7.2
T_2 (2.5%)	3.60	3.57	3.50	3.50	7.8	8.0	8.0	7.7
T_3 (3%)	3.65	3.57	3.54	3.52	7.7	7.8	8.4	7.5
T_4 (3.5%)	3.72	3.70	3.55	3.64	7.8	7.9	8.6	8.2
T_5 (4%)	3.74	3.72	3.60	3.62	8.0	8.2	8.6	8.0
SEm(±)	**0.029**	**0.027**	**0.021**	**0.008**	**0.085**	**0.060**	**0.074**	**0.077**
LSD(0.01)	**NS**	**1.326**	**NS**	**0.389**	**1.916**	**1.321**	**1.576**	**1.803**

Table 2: Effect of salt concentration on acid and lactic acid of Sauerkraut at different days intervals.

	Acidity (mg 100g^{-1})				Lactic acid (mg 100g^{-1})			
Salt %	**7day**	**14 day**	**21 day**	**28 day**	**7day**	**14 day**	**21 day**	**28 day**
T_1 (2%)	1.28	1.44	1.47	1.53	2.51	2.03	2.07	2.16
T_2 (2.5%)	1.15	1.31	2.24	2.24	1.62	1.85	3.15	3.15
T_3 (3%)	0.89	1.08	1.79	1.52	1.26	1.53	2.52	2.14
T_4 (3.5%)	0.64	0.64	1.60	0.83	0.90	0.84	2.25	1.17
T_5 (4%)	0.55	0.66	1.28	0.93	0.78	0.93	1.80	1.33
SEm(±)	**0.024**	**0.027**	**0.034**	**0.034**	**0.027**	**0.027**	**0.034**	**0.034**
LSD(0.01)	**0.076**	**0.085**	**0.106**	**0.109**	**0.086**	**0.085**	**0.106**	**0.109**

Table 3: Effect of salt concentration on ascorbic acid of Sauerkraut at different days intervals.

	Ascorbic acid (mg 100g^{-1})			
Salt %	**7day**	**14 day**	**21 day**	**28 day**
T_1 (2%)	13.34	14.60	26.60	18.43
T_2 (2.5%)	20.89	23.00	36.57	28.41
T_3 (3%)	15.73	16.60	34.42	22.27
T_4 (3.5%)	14.15	17.66	20.68	17.53
T_5 (4%)	16.40	16.00	25.08	17.28
SEm(±)	**0.020**	**0.023**	**0.592**	**0.040**
LSD(0.01)	**0.063**	**0.073**	**1.865**	**0.127**

Table 4: Effect of salt concentration on sensory qualities of Sauerkraut at different days interval

Salt %	**Colour**				**Texture**				**Odour**				**Acceptability**			
	7	**14**	**21**	**28**	**7**	**14**	**21**	**28**	**7**	**14**	**21**	**28**	**7**	**14**	**21**	**28**
T_1 (2%)	8.33	7.67	6.00	6.00	7.33	6.67	6.33	5.67	8.33	7.00	6.67	6.33	8.67	8.33	7.50	6.83
T_2 (2.5%)	8.67	7.00	7.33	7.00	7.67	7.33	6.67	6.00	8.67	8.33	7.50	7.17	9.00	8.50	8.17	7.17
T_3 (3%)	8.33	7.17	5.50	5.33	6.33	5.67	5.33	5.50	8.00	7.00	6.83	5.83	8.00	7.67	7.00	6.17
T_4 (3.5%)	7.67	6.83	5.33	5.33	6.00	5.33	5.00	5.00	8.50	7.17	5.50	5.00	7.67	7.50	6.67	6.00
T_5 (4%)	7.00	6.33	5.00	4.00	5.67	5.17	4.83	4.67	8.00	6.83	5.00	4.50	7.67	7.33	6.50	6.17
SEm(±)	**0.377**	**0.320**	**0.432**	**0.283**	**0.320**	**0.294**	**0.267**	**0.374**	**0.353**	**0.438**	**0.291**	**0.213**	**0.306**	**0.340**	**0.245**	**0.194**
LSD(0.01)	**NS**	**NS**	**NS**	**0.891**	**1.007**	**0.928**	**0.840**	**NS**	**NS**	**NS**	**0.916**	**0.673**	**NS**	**NS**	**0.772**	**0.612**

Note : *Score List: 1.00 – 4.5= Poor, 4.5 – 6.5=Fair, 6.50 – 8.00= Good, 8.00 – 10.00 = Excellent, NS=Non Significant*

of 2.24% followed by 1.79% with 3% salt (T_3), 1.60% with 3.5% salt (T_4) and 1.28% with 4% salt (T_5) respectively. Sauerkraut with 2% salt (T_1) on the other hand obtained maximum acidity of 1.53% on 28th day of fermentation. Lactic acid pre-cent increased with fermentation of sauerkraut. Lactic acid per cent of 3.15%, 2.52, 2.25% and 1.80% was recorded with salt concentration of 2.5%, 3.0%, 3.5% and 4.0% respectively on 21st day while 2% salt concentration recorded maximum (2.16%) lactic acid on 28th day of fermentation .

There was significant difference among the salt concentration for ascorbic acid content at different days of sauerkraut preparations (Table 3). On 7th day of sauerkraut preparation ascorbic acid content was maximum (20.89 mg 100g^{-1}) in T_2 (*i.e.* 2.5%) followed by 16.40 mg100g^{-1} in T_5, 15.73mg 100g^{-1} in T_3, 14.15 in T_4 and 13.34 mg 100g^{-1} in T_1 respectively. Ascorbic acid increased continuously up to 21 days and thereafter on 28 day of sauerkraut preparation ascorbic acid content of all the treatment decreased. On 21st day also ascorbic acid of T_2 *i.e.* 2.5% salt concentration remained significantly higher (36.57 mg 100g^{-1}) than the other treatment.

The sensory parameters (colour, texture, odour and overall acceptability) indicated that on 21 day of preparation of sauerkraut, 2.5% salt concentration (T_2) recorded the highest sensory score for colour (7.33), texture (6.67), odour (7.50) and overall acceptability (8.17). Sensory score was decreased at a salt concentration beyond 2.5%. Thus, it was found that with 2.5% salt concentration (T_2), optimum quality of sauerkraut could be produced on 21 day of fermentation.

The addition of salt is one of the critical point in sauerkraut production because of the type and extent of microbial growth and the sensory properties of the final product are affected by the amount of salt used (Holzapfel *et al*., 2003). Salt of cabbage causes an osmotic imbalance, which results in the release of water and nutrient from cabbage leaves. The fluid expelled is an excellent growth medium for the microorganisms involved in the fermentation. The salt concentration used, inhibits the growth of many spoilage organisms and pathogens (Pederson *al*.,1975). Salt also helps to control the flora of the fermentation by favoring lactic acid producing bacteria and inhibiting the undesirable competitors and in this way salt acts as preservative (Mary,1994). Previous reports (Chauhan *et al*., 2008 and Srivastava,1998) considered a salt concentration of 2-2.5% as ideal for fermentation which is in conformity with the present findings. According to Holzapfel *et al*. (2003) amount of salt depends on consumer demands and usually ranges between 0.6% and 2% NaCl. Chauhan *et al*. (2008) rated sauerkraut of 2.0% salt concentration best with regard to overall acceptability, 2.5% salt concentration had maximum value for texture while the 3.0% salt concentration had lowest sensory score value as compare to other sample.

In the present investigation, it was found that 2.5% salt (T_2) was the best concentration and optimum quality of sauerkraut could be produced on 21 day of fermentation.

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