

Effect of packaging on storage life and quality of cauliflower stored at low temperature

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Abstract Medium sized cauliflower (*Brassica oleracea* var. botrytis) curds after removing outer leaves, sorting and without washing were packed in different packaging films and stored at $0 \pm 1^\circ\text{C}$, 90–95% RH. Changes in curd colour, texture, physiological loss in weight, spoilage and sensory quality were evaluated at weekly interval upto 28 days. Cauliflower curds individual packed in high density polyethylene bags (20 μm) with perforation (6 holes/bag) can be stored up to 21 days at $0 \pm 1^\circ\text{C}$ and 90–95% RH with maximum retention of white colour of curd, minimum spoilage, weight and firmness loss and good sensory quality attributes. The use of cling wrap films should be avoided as this leads to accumulation of excessive moisture resulting in huge spoilage loss.

Keywords Cauliflower · Low temperature storage · Packaging · Quality

Introduction

Cauliflower is important vegetable crop of India known for its curd colour, texture and quality and has great potential in domestic and export market. Its peak period of harvesting falls between November and mid-December resulting in glut of produce in the market and farmers are forced to sell their produce at very low prices. Post-harvest losses in cauliflower at room temperature have been reported to be 10, 2.4, 5 and 15% as decay, trimming, mechanical damage and weight loss, respectively. The estimated post-harvest loss of cauliflower per hectare in India is 49% (Sehgal 1999). Slight increase in off-odour and off-taste was observed during 4th

week of storage of cauliflower (Gajewski and Radzanowska 2003). Several authors have studied the effect of packaging material and storage environment on post-harvest storage life and quality of cauliflower (Mangal et al. 2000, Dell et al. 2003, Rashmi and Smita 2003, Menjura-Camacho and Villamizar 2004). But these studies were restricted to storage conditions other than recommended and were variety specific. Hence, there is a need to store cauliflower at recommended storage conditions ($0 \pm 1^\circ\text{C}$, 90–95% RH) with appropriate packaging technique so that it can maintain its quality during storage till it reaches to consumer. In Punjab, these storage conditions are available in commercial cold stores. Keeping these view points in forefront, the study was conducted.

Firm, compact, medium size, white to creamy white cauliflower (*Brassica oleracea* var. botrytis) curds was harvested in the second week of November from the field of a progressive farmer of Ludhiana district. Harvesting was done with great care to prevent bruising to the highly sensitive turgid curds. The outer leaves of curds were removed leaving 2–3 leaves per curd. The curds were divided into 5 lots of 20 kg each. One lot was used for initial analysis of physical characteristics. Out of remaining 4 lots, one lot was unpacked (control) and the other 3 lots were used for 3 packaging viz., individual seal in HDPE (20 μm) with perforation (6 holes/bag) (T_1), individual seal in LDPE (25 μm) with perforation (6 holes/bag) (T_2) and individual seal in cling wrap (17 μm) (T_3). No washing of curds were done prior to packaging. T_1 and T_2 have 3% ventilation of the total surface area of individual pack. All the packets were kept in plastic crates (20 kg each) and stored at $0 \pm 1^\circ\text{C}$ and 90–95% RH in walk-in cool chamber. Each treatment comprised of 4 crates and at each storage interval (7, 14, 21, 28 days) one crate per treatment was removed from the storage room to record the data on physiological loss in weight (PLW), firmness, instrumental colour, spoilage and overall sensory quality of cauliflower curds. The experiment was laid out in completely randomized block design with 3 replications, each replication comprising of 3 curds.

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The data was analysed statistically (Cochran and Cox 1957). The PLW of curd was calculated as cumulative percent loss in weight based on the initial curd weight (before storage). The firmness of curd was measured with the help of texture analyzer (Model: TA-HDi make, Stable Micro-systems, UK) using compression plates (75 mm diameter) and expressed in kgf. Overall sensory quality was evaluated by a semi-trained panel of 5 persons. The 5-point scale (Excellent-5, very good-4, good-3, fair-2 and poor-1) was used for evaluation. A score below 3 was deemed to indicate the

end of shelf life. Curd spoilage was measured in terms of extent of rotting due to disease and surface blackening. For instrumental colour determination, the reflectance spectra were measured at 3 different points on the cauliflower surface and then the mean reflectance spectrum was obtained. These measurements were taken with colour difference meter (Model: Mini Scan XE Plus, Hunter Lab, USA) and expressed as L, a, and b colour values (Hunter 1975).

Results are presented in Table 1. In general, PLW of curds increased during storage. Cauliflower curds packed in

Table 1 Effect of different packaging films on the physico-chemical changes in cauliflower curd during cold storage at 0±1°C temp and 90–95% RH

Storage period, days	HDPE	LDPE	Cling wrap	Control	CD (p≤0.05) (n=3)
PLW, %					
7	0.20	0.20	0.20	0.25	0.02
14	1.10	1.05	1.15	1.80	0.04
21	1.80	1.90	1.70	4.25	0.08
28	2.25	2.40	2.10	7.15	0.09
Firmness, kg force					
7	1.78	1.74	1.75	1.69	0.03
14	1.48	1.43	1.44	1.32	0.02
21	1.32	1.28	1.30	1.11	0.02
28	1.24	1.16	1.21	1.04	0.03
Hunter colour L					
7	76.1	75.9	74.5	74.0	0.06
14	75.6	74.7	73.4	70.1	0.08
21	75.2	74.0	72.8	68.0	0.09
28	71.8	70.1	68.7	62.7	0.12
Hunter colour a					
7	0.69	0.53	1.23	0.47	0.05
14	0.52	0.00	0.05	0.73	0.18
21	0.15	0.05	0.41	0.79	0.11
28	0.16	-0.17	0.21	0.65	0.09
Hunter colour b					
7	19.5	20.1	19.9	21.0	0.02
14	20.4	21.8	20.4	21.9	0.04
21	20.8	22.5	21.7	22.5	0.04
28	21.9	23.1	22.6	24.6	0.05
Curd spoilage, %					
7	0.5	0.5	1.0	1.0	0.05
14	1.5	1.5	3.0	2.0	0.06
21	3.0	3.5	5.0	4.0	0.08
28	6.0	8.0	9.5	8.0	0.10
Overall sensory quality score					
7	4.8	4.5	4.5	3.5	0.24
14	4.0	3.5	3.0	2.5	0.18
21	3.0	2.8	2.5	1.8	0.22
28	2.0	2.0	2.0	1.0	0.10

T₃ recorded minimum PLW (1.7%) after 21 days of storage. The control curds without packaging recorded maximum weight loss (4.2%) after 21 days. Similar results were also observed in cauliflower by Romo-Parada et al. (1989) and Menjura-Camacho and Villamizar (2004). The reduction in weight loss in T₃ may be due to creation of micro-atmosphere in the wrap which reduced the transpiration losses and respiration rate as the film is differently permeable to O₂ and CO₂ transmission but more spoilage was noticed in T₃. It may be due to direct contact of the film with the curd surface. However, other characters like firmness, instrumental colour and sensory quality were at par with other packaging treatments but due to high level of spoilage such packaging should be avoided.

The firmness showed a linear decline during storage. T₁ recorded slow and gradual decline in firmness during storage and maintained highest final firmness (1.32 kg force) after 21 days storage. The retention of higher firmness in T₁ may be due to lower moisture loss which has direct bearing on curd firmness. The curds without packaging in plastic crates (control) were least firm where sharp decline in firmness was noticed during storage. Similar results were reported by Menjura-Camacho and Villamizar (2004). Kingsly et al. (2004) also observed that firmness of ber decreased during prolonged storage.

The spoilage of cauliflower curds due to physical and mechanical injuries such as bruising, surface blackening and rotting increased during storage irrespective of packaging treatments. Maximum spoilage (5.0%) of curds was observed in T₃ after 21 days of storage. This may be due to direct contact of the film with the curd surface where water vapour accumulation resulted in fungal growth and spoilage. Moreover, shrinking the film with heat may have damage the tissue, providing a more favourable environment for microorganism growth which results in decay of curds (Dell et al. 2003). The control curds kept in plastic crates also registered significant spoilage (4%) after 21 days. Minimum spoilage of 3% after 21 days storage was recorded in T₁. This could be due to restriction in the entry of spoilage microbes from surrounding environment and also due to retention of better curd firmness. Spoilage was more than 5% after 28 days storage in all the treatments and such curds are not suitable for marketing. Similar trend in change of firmness were also reported by Eliot et al. (1999) and Kudachikar et al. (2007) in cauliflower and banana, respectively.

In all the treatments, there was consistent decrease in whiteness (L) and increase in yellowness (b) during storage. In T₁, there was minimum loss of whiteness (L) and development of yellowness (b) in the curd as compared to other treatments. The L value of control curds was much lower and b value was much higher than the other treatments and as a result control curds could not be marketed after 14th days of storage whereas T₁ maintained their whiteness even up to 21 days of storage. After words, there was sharp decline in their whiteness and increase in yellowness. Simi-

lar results were observed by Naik et al. (2001) and Sanz Cervera et al. (2007) in chilli and cauliflower, respectively. Gonzalez et al. (2001) observed that storage environment also affect the curd colour.

T₁ packed curds were excellent in appearance and taste after 14 days of storage and scored very good rank after 21 days of storage (Table 1). On the other hand, the control curds without packaging in plastic crates were rated fair and poor after 14 and 21 days of storage, respectively. However, after 28 days of storage all curds, irrespective of different packaging treatments became soft having fair overall sensory quality and not fit for marketing. Gajewski and Radzanowska (2003) observed slight increase in off-odour and off-taste in cauliflower after 4 weeks of cold storage (0 ± 1°C, 90–95% RH). Our results are in conformity with those reported by Goyal and Russel (1991) and Kudachikar et al. (2007) in cauliflower and banana, respectively.

Conclusion

Cauliflower curds packed in individual HDPE bags could retain white colour, good sensory quality, firm and fresh curds with least loss in weight, texture and minimum spoilage up to 21 days storage at low temperature conditions (0 ± 1°C, 90–95% RH). Therefore without washing followed by packing in individual HDPE bags and storage in cold stores is a commercially viable technology for extending the marketability of cauliflower.

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