

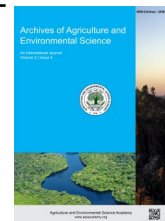


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ORIGINAL RESEARCH ARTICLE



## Performance on postharvest quality of late season cauliflower (*Brassica oleracea* var. *botrytis* L.) varieties in Terai region of Nepal

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### ABSTRACT

The experiment was conducted at Horticulture Farm of Agriculture and Forestry University, Rampur, Nepal during the November 2016 to March 2018 for two consecutive years to assess the characteristics on postharvest quality of late season cauliflower varieties. The experiment was laid in a Randomized Complete Block Design (RCBD) with the eleven late season cauliflower varieties viz., Freedom, Titan, Ravella, Amazing, Artica, Bishop, Casper, Indam 9803, NS 106, Snow Mystique, and Snowball 16, each replicated with four times. Significantly higher TSS value of 5.7° Brix was produced by Snowball 16 than other varieties. Considerably higher vitamin C of 49 mg/100 g was found in Amazing than other varieties. Significantly lower physiological loss in weight of 5.3%, 9.6% and 15.6% was found in Artica at three, six and nine days after harvesting, respectively. Higher score for the taste of curd was 8.8 in Snowball 16 followed by Amazing while lower score for taste of the curd was 4.8 in Indam 9803 variety. The attractive color and more compact curd score of 8.4 was found in both Titan and Artica than other varieties. Therefore, it can be concluded that Snowball 16 and Amazing varieties were the best open pollinated varieties for taste of the curd and composition of chemical constituents. Bishop, Snow Mystique, NS 106, Artica and Titan varieties were other probable hybrid varieties based on their overall postharvest characteristics.

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### INTRODUCTION

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is one of the important vegetables among the Cole crops belonging to the family Brassicaceae. It can be grown effectively from inner Terai to the high hills (Pandey and Pokhrel, 2000; Pandey, 2003). Cauliflower is rich source of vitamins and minerals which can protect against heart disease and also helps to maintain cholesterol level if consumed regularly (Keck, 2004). Edible part curd is consumed as cooking vegetables, curry, raw as salad, pickle, and widely used in preparing fried snacks, burger and sandwich in the restaurants (Ashraf *et al.*, 2017). Cauliflower is highly sensitive to climatic factors that play an important role on curd initiation and growth of the curds. Cauliflower productivity

is highly influenced by the genetic characteristics of the cultivar, planting time and growing temperature (Chatterjee and Mahanta, 2013). The physiological changes such as curd formation, normal curd development occurs under suitable environmental conditions and then begin flowering (Labate *et al.*, 2006). Based on the temperature requirement for curding and its maturity period, the Indian cauliflower varieties are classified in to five different groups as extra early (20-27°C), early (20-25°C), medium (16-20°C), mid-late (12-16°C) and late (10-16°C) groups (Singh and Nath, 2011). In Nepal, Major early season cauliflower varieties registered in Nepal are Silver Cup, White Flash, Sarlahi Depali. Similarly, mid-season varieties are Kathmandu Local, Khumal Jyapu, Snow Dome, Milky Way, Rami, White Top, Devi-1 and late season varieties are Dolpa Snow

Ball, Snow Mystique, Mega, NS-90, NS106 (Krishi diary, 2019). Farmers are always in search of suitable varieties based on temperature requirement with desirable traits such as productivity, quality and resistance to important insect pests and diseases (Poudel et al., 2002; Kumar et al., 2019). Selection of suitable varieties to environmental factors and soil types are of paramount importance in growing cauliflower (Kindo, 2018). In fact, unavailability of appropriate varieties for higher yield and better postharvest quality are the major problems faced by the vegetable growers in Terai region of Nepal (HRD, 2013). Information regarding the postharvest quality of late season varieties in Terai region is inadequate so it is essential to identify late season cauliflower varieties which can mitigate the negative impacts of higher temperature and its impact on production of quality curd. Therefore, an experiment was conducted to assess the postharvest quality of late season cauliflower varieties in Terai region of Nepal.

## MATERIALS AND METHODS

An experiment on postharvest assessment of late season cauliflower varieties were conducted at Horticulture Farm of Agriculture and Forestry University, Rampur, Nepal situated at 27°37' North latitude and 84°25' East longitude with elevation of 256 meter above sea level that falls in Terai region of Nepal. This experiment was carried out during November 2016 to March 2018 for two growing seasons to assess the characteristics on postharvest quality of major cauliflower varieties in Rampur, Chitwan, Nepal.

### Weather parameters of the experimental area

The weather parameters such as monthly maximum and minimum atmospheric temperature, relative humidity and total rainfall in Rampur, Chitwan during the cauliflower-growing period for two growing seasons from November 2016 to March 2018 was collected from National Maize Research Program Rampur, Chitwan. In the first year, maximum temperature of 29°C was recorded in November 2016 and March 2017 while the minimum temperature of 10°C was noticed in January 2017. Similarly, maximum and minimum relative humidity of 95% and 77% was recorded in January 2017 and November 2016, respectively. In the second year, maximum temperature of 33°C

was recorded in March 2018 while the minimum temperature of 9°C was observed in January 2018. Similarly, the maximum and minimum relative humidity of 96% and 71% was recorded in January 2018 and March 2018 respectively. There was negligible rainfall for whole experimental period in both years.

### Experiment design and treatments

An experiment was conducted by arranging the treatments in a Randomized Complete Block Design with four replications comprised of eleven late season cauliflower varieties viz., Freedom, Titan, Ravella, Amazing, Artica, Bishop, Casper, Indam 9803, NS 106, Snow Mystique and Snowball 16. The area of individual plot was 7.5 m<sup>2</sup> (3 m × 2.5 m) with 25 plants. Row to row distance was maintained at 60 cm and plant to plant distance was also continued at 50 cm. The varieties used in this experiment are listed in Table 1.

### Soil properties of the experimental field

The soil samples from each plot were taken for chemical analysis before the transplanting of seedlings. The air dried and filtered soil was taken in to the lab at Agriculture Technological Centre, Lalitpur to measure the total nitrogen, phosphorus, potassium, organic matter, soil pH and soil texture. The experimental field was slightly acidic with 5.4 to 5.6 soil pH; medium nitrogen and potassium content, low phosphorus content, high organic matter content and sandy loam in both years (Table 2).

The total amount of 22.5 kg farmyard manure, 195 g DAP, 152 g urea and 100 g murate of potash per plot was incorporated in the soil during field preparation as a basal dose and 98 g urea was applied at 40 days after transplanting as a split dose based on the recommended dose of fertilizer. The seedlings were transplanted in the main field when they were ready for transplanting about four weeks after the seed sowing. The water application was continued until the establishment of seedlings in the main field. Total soluble solids (TSS), titrable acidity (TA), concentration of hydrogen ion (pH) and vitamin C after harvesting of cauliflower curds were measured from those randomly selected five plants of each plot. Similarly, physiological loss in weight (%), organoleptic taste and sensory evaluation of cauliflower curds were assessed from those randomly selected plants.

**Table 1.** Late season cauliflower varieties planted in Rampur, Chitwan for two growing seasons from November 2016 to March 2018.

Varieties	Source	Variety type
Freedom	Park seed, USA	Hybrid
Titan	Osborne seed, USA	Hybrid
Ravella	Osborne seed, USA	Hybrid
Amazing	Territorial seed company, USA	OP variety
Artica	Stokes seeds, New York, USA	Hybrid
Bishop	Rijk Zwaan, Netherlands	Hybrid
Casper	Rijk Zwaan, Netherlands	Hybrid
Indam 9803	Indo-American hybrid seed, India	Hybrid
NS 106	Namdhari seeds Pvt. Ltd., India	Hybrid
Snow Mystique	Takii seed, Japan (Available in Nepal)	Hybrid
Snowball 16	Vegetable seed production center, Dolpa	OP variety

**Table 2.** Characteristics of soil at experimental field in Rampur, Chitwan during November 2016 to March 2018.

Soil parameters	Mean value of soil parameters	
	2016/2017	2017/2018
Total nitrogen (%)	0.19	0.15
Phosphorous (kg/ha)	42	47.6
Potash (kg/ha)	118	216.6
Organic matter (%)	4.2	3.9
pH	5.6	5.4
Soil type	Sandy loam	Sandy loam

### Statistical analysis

Data were recorded and entered into MS-Excel 2016. The analysis of variance (ANOVA) was identified and means were compared using Duncan's Multiple Range Test (DMRT). The significant differences between varieties on postharvest quality parameters were determined by using the least significant difference (LSD) test at 1% or 5% level of significance (Gomez and Gomez 1984; Shrestha, 2019).

## RESULTS AND DISCUSSION

### Chemical parameters of cauliflower

Total soluble solid (TSS), titrable acidity (TA), concentration of power of hydrogen ions (pH) and vitamin C were measured parameters on chemical parameters of cauliflower. TSS content and vitamin C value were differed significantly at  $p < 0.01$  among the varieties while there was no significantly differed on TA and pH among the varieties (Table 3). Significantly higher TSS value of 5.7° Brix was produced by Snowball 16 than other varieties. Significantly maximum Vitamin C value of 49 mg/100 g was recorded in Amazing followed by Snowball 16 than other varieties. The TSS value was higher in Snowball 16 followed by Amazing than other hybrid varieties that might be due to variation in genetic characteristics of the varieties which were introduced

from various countries. In this experiment, open pollinated varieties showed better performance on production of TSS and vitamin C than hybrid varieties. The postharvest performance of vegetable crops could be concerned to both genetic and environmental influences such as nutrient source, climatic condition, soil fertility status, as similar finding was mentioned by Abbey et al. (2002).

### Physiological loss in weight

Physiological loss in weight (PLW) was differed significantly at  $p < 0.01$  among the treatments at three, six and nine days after harvesting (Table 4). Significantly, lower physiological loss in weight of 5.3%, 9.6% and 15.6% was found in Artica than other varieties at three, six and nine days after harvesting respectively. Similarly, considerably higher physiological loss in weight of 9.2%, 17.7% and 27.2% was recorded in Snowball 16 than other varieties at three, six and nine days after harvesting, respectively. The variation on postharvest quality of cauliflower within the varieties were due to the genetic characteristics of the cultivars, which were introduced from different countries. This variation on postharvest quality parameters like physiological loss in weight was found among the late season varieties of cauliflower, as similar findings was reported by other researchers (Yadav et al., 2013 and Kumar et al., 2011).

**Table 3.** Biochemical parameters of cauliflower for two year's mean in Rampur, Chitwan during November 2016 to March 2018.

Treatments	Chemical parameters			
	TSS (°Brix)	TA (%)	pH	Vitamin C (mg/100 g)
Freedom	4.3 <sup>bc</sup>	0.4	6.7	38.3 <sup>cd</sup>
Titan	4.2 <sup>bcd</sup>	0.4	6.7	39.1 <sup>bcd</sup>
Ravella	4.0 <sup>cd</sup>	0.4	6.7	39.3 <sup>bcd</sup>
Amazing	4.7 <sup>b</sup>	0.4	6.7	49.0 <sup>a</sup>
Artica	4.1 <sup>cd</sup>	0.3	6.7	38.5 <sup>bcd</sup>
Bishop	4.4 <sup>bc</sup>	0.3	6.7	46.6 <sup>ab</sup>
Casper	4.0 <sup>cd</sup>	0.4	6.8	34.0 <sup>d</sup>
Indam 9803	3.7 <sup>d</sup>	0.3	6.7	39.2 <sup>bcd</sup>
NS 106	4.2 <sup>bc</sup>	0.4	6.8	45.4 <sup>abc</sup>
Snow Mystique	4.6 <sup>b</sup>	0.4	6.7	45.7 <sup>abc</sup>
Snowball 16	5.7 <sup>a</sup>	0.4	6.7	46.5 <sup>ab</sup>
SEM	0.21	0.03	0.15	3.50
LSD <sub>0.05</sub>	0.43 <sup>**</sup>	ns	ns	7.01 <sup>**</sup>
CV, %	9.8	14.7	4.5	14.4

Means with same letter in column are not significantly different at  $p = 0.05$  by DMRT. \*Significant at 5% ( $p < 0.05$ ), \*\* Significant at 1% ( $p < 0.01$ ) and ns: not significantly different at 5% ( $p > 0.05$ ). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variance.

**Table 4.** Physiological loss of cauliflower for two year's mean at different intervals in Rampur, Chitwan during November 2016 to March 2018.

Treatments	Physiological loss in weight (%)		
	3 DAH	6 DAH	9 DAH
Freedom	6.6 <sup>bc</sup>	12.5 <sup>bcd</sup>	19.9 <sup>bc</sup>
Titan	5.6 <sup>cd</sup>	10.5 <sup>ef</sup>	16.7 <sup>cde</sup>
Ravella	7.0 <sup>b</sup>	13.7 <sup>bc</sup>	20.5 <sup>b</sup>
Amazing	6.9 <sup>b</sup>	13.1 <sup>bc</sup>	21.1 <sup>b</sup>
Artica	5.3 <sup>d</sup>	9.7 <sup>f</sup>	15.6 <sup>e</sup>
Bishop	5.6 <sup>cd</sup>	10.4 <sup>ef</sup>	16.0 <sup>de</sup>
Casper	6.9 <sup>b</sup>	14.0 <sup>b</sup>	20.4 <sup>b</sup>
Indam 9803	7.0 <sup>b</sup>	13.0 <sup>bcd</sup>	20.1 <sup>bc</sup>
NS 106	6.0 <sup>bcd</sup>	11.3 <sup>def</sup>	18.1 <sup>bcdde</sup>
Snow Mystique	6.4 <sup>bc</sup>	12.2 <sup>cde</sup>	19.4 <sup>bcd</sup>
Snowball 16	9.2 <sup>a</sup>	17.7 <sup>a</sup>	27.2 <sup>a</sup>
SEM	0.49	0.79	1.49
LSD <sub>0.05</sub>	1.03 <sup>**</sup>	1.66 <sup>**</sup>	3.12 <sup>**</sup>
CV, %	9.1	7.7	9.4

Means with same letter in column are not significantly different at  $p = 0.05$  by DMRT. \*Significant at 5% ( $P < 0.05$ ), \*\* Significant at 1% ( $p < 0.01$ ) and ns: not significantly different at 5% ( $p > 0.05$ ). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variance and DAH = Day after harvesting.

**Table 5.** Organoleptic taste and sensory evaluation of cauliflower curds for two year's mean in Rampur, Chitwan during November 2016 to March 2018.

Treatments	Organoleptic taste and sensory evaluation of curds			
	Taste (1-9)	Color (1-9)	Compactness (1-9)	Acceptability (1-9)
Freedom	7.5 <sup>d</sup>	7.0 <sup>d</sup>	7.7 <sup>c</sup>	7.0 <sup>d</sup>
Titan	7.3 <sup>e</sup>	7.0 <sup>c</sup>	8.5 <sup>a</sup>	7.6 <sup>b</sup>
Ravella	5.2 <sup>f</sup>	5.0 <sup>e</sup>	6.8 <sup>e</sup>	5.4 <sup>f</sup>
Amazing	8.5 <sup>b</sup>	7.9 <sup>b</sup>	7.6 <sup>cd</sup>	7.7 <sup>b</sup>
Artica	7.8 <sup>c</sup>	8.4 <sup>a</sup>	8.4 <sup>a</sup>	7.5 <sup>bc</sup>
Bishop	7.9 <sup>c</sup>	7.7 <sup>b</sup>	8.0 <sup>b</sup>	8.0 <sup>a</sup>
Casper	5.0 <sup>f</sup>	4.9 <sup>e</sup>	6.4 <sup>f</sup>	4.1 <sup>g</sup>
Indam 9803	4.8 <sup>g</sup>	6.3 <sup>d</sup>	7.4 <sup>d</sup>	5.8 <sup>e</sup>
NS 106	8.5 <sup>b</sup>	7.9 <sup>b</sup>	7.7 <sup>c</sup>	8.2 <sup>a</sup>
Snow Mystique	8.5 <sup>b</sup>	7.9 <sup>b</sup>	7.6 <sup>cd</sup>	8.0 <sup>a</sup>
Snowball 16	8.8 <sup>a</sup>	6.5 <sup>d</sup>	5.0 <sup>g</sup>	7.0 <sup>d</sup>
SEM	0.11	0.20	0.14	0.11
LSD <sub>0.05</sub>	0.23 <sup>**</sup>	0.42 <sup>**</sup>	0.29 <sup>**</sup>	0.23 <sup>**</sup>
CV, %	1.9	3.6	2.4	2.0

Means with same letter in column are not significantly different at  $p = 0.05$  by DMRT. \*Significant at 5% ( $p < 0.05$ ), \*\* Significant at 1% ( $p < 0.01$ ) and ns: not significantly different at 5% ( $p > 0.05$ ). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variance. [9 score was a superior value on rating].

### Organoleptic taste and sensory evaluation

Taste, color, compactness and acceptability of the curds were differed significantly at  $p < 0.01$  among the late season cauliflower varieties in Rampur, Chitwan (Table 5). Significantly better tasty curd score of 8.8 was observed in Snowball 16 than other varieties. Considerably more attractive color curd score of 8.4 was recorded in Artica than other varieties. Similarly, higher compact curd score of 8.5 was found in Titan and Artica than other varieties. Finally, significantly higher acceptability score of 8.2 was recorded in NS 106, Snow Mystique and Bishop than

other varieties. The significant variation on postharvest quality of cauliflower were influenced by the environmental factors and management practices, as similar findings were achieved by various researcher (Meena et al., 2010; Sharma et al., 2018). The taste, color and compactness of the cauliflower were also differed significantly due to its genetic characteristics of the varieties. The tastier curds were produced by Snowball 16 followed by Amazing than other hybrid varieties. Snowball 16 performed tastier curds than other varieties, as similar findings was supported by Pun et al. (2013).

## Conclusion

The result of the experiment revealed that biochemical parameters such as TSS, TA, pH and vitamin C along with physiological loss in weight, organoleptic taste and sensory evaluation were differed significantly among the major late season varieties of cauliflower. The highest TSS value of 5.7° Brix was obtained in Snowball 16 while the maximum vitamin C of 49 mg/100 g was produced by Amazing. Significantly lower physiological loss in weight of 5.3%, 9.6% and 15.6% was found in Artica than other varieties at three, six and nine days after harvesting respectively. Significantly higher score for taste of curd was found in Snowball 16 followed by Amazing while lower score for taste of the curd was recorded by Indam 980. The attractive color and more compact curds were found in both Titan and Artica than other varieties. From this experiment, it can be concluded that Snowball 16 and Amazing were the best open pollinated varieties based on the taste and composition of chemical constituents in cauliflower curds. Finally, Bishop, Snow Mystique, NS 106, Artica and Titan were other probable hybrid varieties while Ravella, Casper and Indam 9803 were less preferable varieties based on their overall postharvest characteristics.

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## Conflict of interest

The authors declare no conflicts of interest regarding publication of this manuscript.

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