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Curd quality of late-season cauliflower varieties in Nepal's mid-hill region

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Abstract

Due to higher temperatures in Nepal's mid-hill region, postharvest quality of cauliflower faces significant challenges during the late winter season. To address this issue, a field experiment was conducted to evaluate the curd quality of eleven late-season cauliflower varieties. The experiment was set up in a Randomized Complete Block Design (RCBD), with nine hybrid varieties (Freedom, Titan, Ravella, Artica, Bishop, Casper, Indam 9803, NS 106, and Snow Mystique) and two open pollinated varieties (Amazing and Snowball 16). The experiment was carried out over four replications from November 2016 to March 2018. Snowball 16 had the highest TSS value of 5.5 °Brix and pH of 6.5 when compared to other varieties. Snow Mystique had the highest vitamin C content of 48.5 mg/100 g, followed by Amazing and Snowball 16, compared to other varieties. At three, six, and nine days after harvesting, physiological weight loss was 4.0 percent and 8.0 percent in Bishop, and 13.3 percent in Artica, respectively. Snowball 16 received a significantly higher score of 8.5 tasty curds, followed by Amazing. Titan and Artica produced curds with the best appearance and compactness when compared to other varieties. Artica and Titan produced significantly more fresh curds than other varieties. Based on the taste and chemical parameters of the curds for the late winter season in Nepal's Mid-hill region, it was determined that Amazing was the best OP variety, while Artica, Titan, and Bishop were better hybrid varieties.

Key words: Organoleptic taste, physiological loss, shelf-life, freshness, sensory evaluation

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is an important vegetable crop which is the king of Cole crops. The edible part *i.e.,* curd is generally white in color and may be enclosed by inner leaves before its exposure. It can be grown effectively from inner Terai to high hill region of Nepal with adaptability of different ecological conditions (Pandey and Pokhrel, 2000). Cauliflower is a rich source of vitamins and minerals which can protect against heart diseases and also maintain cholesterol level if consumed regularly (Keck, 2004). Curd is used as cooking vegetables and curry along with fresh salad and pickles (Kabiraj *et al*., 2017).

Productivity of cauliflower is highly influenced by the genetic characteristics of the varieties, planting time and growing temperature (Chatterjee and Mahanta, 2013). Kindo (2018) also reported the importance of growing of cauliflower based on selection of suitable varieties, environmental factors and soil types. Nepalese cauliflower varieties are classified in to three groups as early season: Silver Cup, White Flash, and Sarlahi Depali; mid-season: Kathmandu Local, Milky Way, Rami, and Snow Dome; and late season: Snowball 16, Snow Mystique, and NS106 (Krishi diary, 2019). Similarly, 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 based on the temperature requirement for curding (Singh and Nath, 2011).

In Nepal, unavailability of appropriate cauliflower varieties for better quality and higher curd yield were main problems faced by the commercial vegetable growers during late winter season (HRD, 2013). Poor curd quality along with long cropping duration for final maturity were the major problems during late winter growing of cauliflower (Bose and Som, 1993). 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*., 2017). Information regarding the postharvest quality of late season cauliflower varieties in mid hill region of Nepal are insufficient. So, a field experiment was carried out to assess the postharvest quality of cauliflower varieties in mid hill region of Nepal and identify the late season cauliflower varieties which can mitigate the negative effects of higher temperature and its impact on production of good quality curds.

Materials and methods

A field experiment was conducted to assess the curd quality of late season cauliflower varieties during November 2016 to March 2018 for two consecutive years. The research was conducted at farmer's field in Puranchaur, Kaski that is situated at 28°32′ north latitude and 83°99′ east longitude with elevation of 900 masl, which falls in mid-hill region of Nepal. Monthly average maximum and minimum atmospheric temperature, relative humidity (RH) and total rainfall during cauliflower growing period from November 2016 to March 2018 for two successive years was collected from Puranchaur meteorological station in Puranchaur, Kaski.

Experiment design and treatments: A field experiment was carried out to assess the curd quality of late season cauliflower

varieties *viz.,* Freedom, Titan, Ravella, Amazing, Artica, Bishop, Capser, Indam 9803, NS 106, Snow Mystique and Snowball 16. The treatments were arranged in a RCBD with four replications. The area of individual plot was 7.5 m^2 (3 × 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 introduced and Nepalese varieties used in this experiment are listed in Table 1.

Table 1. List of late season cauliflower varieties planted in Puranchaur, Kaski for two growing seasons from November 2016 to March 2018

Varieties	Available seed company	Variety type
Freedom	Park seed, USA	Hybrid
Titan	Osborne seed, USA	Hybrid
Ravella	Osborne seed, USA	Hybrid
Amazing	Territorial seed company, USA	OP
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, Nepal	OP

OP: Open pollinated

Field preparation and transplanting: The soil samples from each plot was taken for chemical analysis before the transplanting of seedlings. The prepared soil was taken in to the soil lab of Agriculture Technological Centre (ATC), Lalitpur to measure total nitrogen, phosphorus, potassium, organic matter, soil pH and texture. The experimental field was slightly acidic with 5.6-5.8 soil pH; medium nitrogen and potassium content, low phosphorus content, medium organic matter content and sandy loam in both years. Total amount of 22.5 kg FYM, 195 g DAP, 152 g urea and 100 g murate of potash per plot was applied in the soil during field preparation as a basal dose. Remaining dose of 98 g urea was applied at 40 days after transplanting as a split dose. The seedlings were transplanted in the main field when they were ready for transplanting after four weeks of the seed sowing. The water application was continued until the establishment of seedlings in the main field.

Data measurement and analysis: Total soluble solids (TSS), titrable acidity (TA), concentration of hydrogen ion (pH) and vitamin C of cauliflower curds were measured in randomly selected five plants of each plot. Similarly, physiological loss in weight (%), organoleptic taste and sensory evaluation of curds, and finally freshness of the curds after harvesting were evaluated in randomly selected plants. Data were recorded and entered into MS-Excel 2016. The analysis of variance (ANOVA) was analyzed by using Genstat 18th edition and means were compared using Duncan's Multiple Range Test (DMRT) at P=0.05 (Gomez and Gomez 1984; Shrestha, 2019).

Results and discussion

Weather parameters: During November 2016 to March 2017, maximum temperature of 25ºC was recorded in November 2016 and March 2017 while minimum temperature of 6ºC was observed in January 2017. Similarly, maximum and minimum relative humidity of 78 and 60 % was found in December 2016 and February 2017 respectively. There was negligible rainfall for whole experiment period except 146 mm in March 2017. In November 2017 to March 2018, maximum temperature of 26ºC was recorded in March 2018 while minimum temperature of 5ºC was observed in January 2018. Similarly, maximum and minimum relative humidity of 79 and 61 % was recorded in December 2017 and March 2018, respectively. There was negligible rainfall for whole experiment period except 91 mm in March 2018

Chemical parameters of cauliflower: Total soluble solid (TSS), concentration of power of hydrogen ions (pH) and vitamin C were measured parameters under chemical parameters of cauliflower. TSS, pH and vitamin C value differed significantly at P<0.01 among the varieties (Table 2). Significantly higher TSS of 5.5 ºBrix was produced by Snowball 16 than other varieties while the lowest TSS was produced by Titan. The TSS 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. Similarly, significantly higher pH (6.5) was recorded in Snowball 16 than other varieties; however, Snowball 16 was statistically at par with Casper, Indam 9803, NS 106 and Snow Mystique. Significantly higher vitamin C content (48.5 mg/100 g) was found in Snow Mystique which was statistically at par with many other varieties. In this experiment, open pollinated varieties showed better performance on production of TSS and vitamin C than hybrid varieties. The curd yield along with curd quality of the cauliflower are polygenic in nature, as it was influenced by the management practices during cauliflower growing period and environmental factors. Similar findings was also reported by Meena *et al*. (2010) and Sharma *et al*. (2018). The postharvest quality of cauliflower was influenced by different genetic and environmental factors such as nutrient source, climatic condition and soil fertility status. Similar finding was also reported by Abbey *et al*. (2002).

Table 2. Mean TSS, pH and vitamin C of cauliflower in Puranchaur, Kaski during November 2016 to March 2018

Treatments	TSS (ºBrix)	pH	Vitamin C (mg/100 g)
Freedom	4.5^{bcd}	6.1^{d}	42.4^{abcd}
Titan	3.7^{e}	6.3^{c}	44.3^{abc}
Ravella	4.1^{cde}	6.4^{bc}	39.2^{cd}
Amazing	4.7^{b}	6.4^{bc}	47.0^{ab}
Artica	4.0^{de}	6.4^{bc}	43.2^{abc}
Bishop	4.4^{bcd}	6.3^{c}	45.3^{abc}
Casper	4.2^{bcde}	6.5^{ab}	36.4^{d}
Indam 9803	4.0^{de}	6.5^{ab}	40.7^{bcd}
NS 106	4.1^{cde}	6.4^{abc}	45.2^{abc}
Snow Mystique	4.6^{bc}	6.4^{abc}	48.5^{a}
Snowball 16	5.5^{a}	6.5^{a}	46.9^{ab}
Grand mean	4.40	6.45	43.60
$LSD_{0.05}$	0.52	0.09	6.00

Means with same letter in column are not significantly different at P=0.05 by DMRT. LSD = Least significant difference, TSS = Total soluble solid, and pH = Concentration of hydrogen ions

Physiological weight loss: Physiological weight loss differed significantly at P<0.01 among the varieties at three, six and nine days after harvesting (Table 3). At three days after harvesting (DAH,) significantly lower physiological weight loss of 4.4 % was recorded in Titan than other varieties, whereas Titan was statistically at par with Artica. At 6 DAH, significantly lower physiological weight loss of 8.0 % was recorded in Bishop than other varieties. At 9 DAH, significantly lower physiological weight loss of 12.8 %

was recorded in Artica than other varieties, whereas Artica was statistically at par with Bishop. Significantly higher physiological weight loss of 7.6, 14.1 and 23.8 % was also recorded in Snowball 16 than other varieties at 3, 6 and 9 DAH, respectively. The variation in postharvest quality of cauliflower within the varieties was due to the genetic characteristics of the cultivar, which was introduced from different countries. This variation in postharvest quality parameters like physiological weight loss among the late season varieties of cauliflower was similar to the earlier reports (Yadav *et al*., 2013; Kumar *et al*., 2011).

Table 3. Mean physiological loss in weight after harvesting of cauliflower in Puranchaur, Kaski during two cropping seasons

Treatments	Physiological weight loss (%)		
	3 DAH	6 DAH	9 DAH
Freedom	4.6^{f}	9.7^{e}	17.9^{d}
Titan	4.4^{g}	10.4^{d}	15.7^{f}
Ravella	6.1^{c}	12.5^{b}	19.7^{c}
Amazing	5.8^{d}	11.4^{c}	16.5^{e}
Artica	4.5^{fg}	9.0^{f}	12.8^{h}
Bishop	4.0^{h}	8.0^{g}	13.3^{gh}
Casper	6.7^{b}	12.8^{b}	19.6^{c}
Indam 9803	6.7^{b}	13.0^{b}	20.6^{b}
NS 106	4.0^{h}	9.3^{ef}	15.3^{f}
Snow Mystique	4.8^{e}	9.3^{ef}	13.6^{g}
Snowball 16	7.6^{a}	14.1^{a}	23.8^{a}
Grand mean	5.4	10.9	17.2
$LSD_{0.05}$	0.2	0.5	0.7

Means with same letter in column are not significantly different at P=0.05 by DMRT. LSD = Least significant difference and DAH = Day after harvesting

Organoleptic taste and sensory evaluation: Taste, compactness and appearance of curds differed significantly at P<0.01 among the late season cauliflower varieties in Puranchaur, Kaski (Table 4). Significantly better tasty curds of 8.5 score were observed in Snowball 16 than other varieties while the lowest score (4.8) was found in Indam 9803. Similarly, highly compact curds of 8.2 score was found in Titan and Artica than other varieties while the lowest score was noticed in Snowball 16. Significantly better appearance curds of 7.6 score was observed in Artica, Bishop and Snow Mystique than other varieties; however, these three varieties were statistically at par with NS 106 and Titan. The significant variation in postharvest quality of cauliflower was influenced by the environmental factors and management practices as reported by various researcher (Meena *et al.,* 2010 and Sharma *et al*., 2018). The taste, color and compactness of the cauliflower were also differed significantly due to the genetic characteristics of the varieties. The tastier curds were produced by Snowball 16 followed by Amazing than other hybrid varieties as also reported by Pun *et al.* (2013).

Freshness of curds: Freshness of curds differed significantly at P<0.01 among the varieties at 3, 6 and 9 days after harvesting (Table 5). At three days after harvesting, significantly higher score of 7.5 was produced by Artica than other varieties, however Artica was statistically at par with Amazing and Snow Mystique. At 6 DAH, significantly higher scores of 7.0 fresh curds were produced by Artica than other varieties, as Artica was statistically at par with Amazing, Snow Mystique and NS 106. At 9 DAH, significantly higher score (6.5) for fresh curd was produced by Artica than other varieties; however, Artica was statistically at par with Amazing and Snow Mystique. Ravella and Casper produced

Table 4. Mean organoleptic taste and sensory evaluation of cauliflower curds Puranchaur, Kaski during two cropping seasons

Treatments	Organoleptic taste and sensory evaluation of cauliflower (1-9 score)		
	Taste	Compactness	Appearance
Freedom	7.2^{d}	7.5^{c}	6.9^{c}
Titan	7.0^{d}	8.2^{a}	7.5^{ab}
Ravella	5.1^{e}	6.5^{d}	5.2^{d}
Amazing	8.2^{b}	7.4^{c}	7.3^{b}
Artica	7.5^{c}	8.2^{a}	7.6^{a}
Bishop	7.5^{c}	7.8^{b}	7.6^{a}
Casper	5.0^{e}	6.1^{e}	4.5^{e}
Indam 9803	4.8^{f}	7.1^{c}	5.4^{d}
NS 106	8.0^{b}	7.5^{bc}	7.5^{ab}
Snow Mystique	8.2^{b}	7.4^{c}	7.6^{a}
Snowball 16	8.5^{a}	4.9^{f}	5.2^{d}
Grand mean	7.07	7.17	6.64
$LSD_{0.05}$	0.22	0.32	0.28

Means with same letter in column are not significantly different at P=0.05 by DMRT. SEM = Standard error of mean, LSD = Least

significantly lower scores of fresh curds than other varieties. The postharvest quality of cauliflower among the late season varieties differed significantly due to genetic characteristics of cultivars similar to the findings of Booij (1990).

Table 5. Mean freshness of curds after harvesting of cauliflower in Puranchaur, Kaski during two cropping seasons

Treatments	Freshness of cauliflower curds (1-9)		
	3 DAH	6 DAH	9 DAH
Freedom	5.9^{d}	5.4^{d}	4.7^{de}
Titan	6.4^{c}	5.9^{c}	5.6^{c}
Ravella	4.5^{e}	4.0^{e}	3.5^{f}
Amazing	7.2^{ab}	6.7^{ab}	6.2^{ab}
Artica	7.5^{a}	7.0^{a}	6.5^{a}
Bishop	6.9^{b}	6.6^{b}	6.0^{b}
Casper	4.5^{e}	4.0^{e}	3.4^{f}
Indam 9803	5.7^{d}	5.1^{d}	4.6^{e}
NS 106	7.1^{b}	6.6^{ab}	6.1^{b}
Snow Mystique	7.2^{ab}	6.7^{ab}	6.2^{ab}
Snowball 16	5.9^{d}	5.4^{d}	5.0d
Grand mean	6.3	5.8	5.3
$LSD_{0.05}$	0.3	0.3	0.3

Means with same letter in column are not significantly different at P=0.05 by DMRT. LSD = Least significant difference and DAH= Day after harvest

The highest TSS value was found in Snowball 16, while maximum vitamin C was recorded in Snow Mystique. Significantly lower physiological weight loss was recorded in Bishop and Artica than other varieties. More tasty curds were produced by Snowball 16 followed by Amazing. Titan and Artica produced the best appearance and compact curds than other varieties. From this study, it was concluded that Amazing was the better open pollinated variety than Snowball 16 while Artica and Titan were better among hybrid varieties.

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