Nepalese Horticulture 17 : 79-85, 2023
ISSN : 2092-1122 | Print : 2542-2936(Online)
DOI: https://doi.org/10.3126/nh.v17i1.60638

Research Article

OPEN ACCESS

Post-Harvest and Sensory Quality Performance of Open Pollinated Cauliflower Cultivars for Mid-season at Dang District of Nepal

Manoj Basnet[1*], Arvind Srivastava[2], Kalyani Mishra[2] and Kishor Chandra Dahal[1]

[1]*Tribhuvan University, Institute of Agriculture and Animal Science, Kiritipur, Kathmandu*

[2]*Agriculture and Forestry University, Faculty of Agriculture, Rampur, Chitwan*

[*]Corresponding Author's Email: manoj@iaas.edu.np

[*]Orcid ID: 0000-0002-9442-9793

Received on: 15 August, 2023 **Revised on:** 10 December, 2023 **Accepted on:** 11 December, 2023

Abstract

The study was conducted at Tulsipur, Dang, Nepal for two years (2021 and 2022 A.D.) to assess the postharvest quality performance of open pollinated (OP) cauliflower curd. Five OP cauliflower cultivars viz. Kathmandu Local, Khumal Jyapu, Agheni, Terai-1 and Terai-2 (seed sourced from Nepal Agriculture Research Council, Khumaltar, Lalitpur) were replicated four times in Randomized Complete Block Design. Freshly harvested curds from respective plots were considered in postharvest and sensory study. Maximum curd dry matter (15.91%) and Vitamin C content (37.94 mg/100 gm) was recorded in Khumal Jyapu whereas, maximum leaf dry matter (12.53%) and TSS (7.1830Brix) were recorded in Aghani. The color score (8.913) and overall appearance score (7.908) were maximum in Khumal Jyapu. The curd compactness score (7.475) and overall acceptance score (8.133) were recorded maximum in Aghani. The lowest physiological loss in curd weight with jacket leaves (8.193%) was recorded in Khumal Jyapu after 3 days after harvesting (DAH) whereas; the lowest physiological loss in curd weight recorded in Aghani were 13.47%, 19.32%% and 25.06% at 5, 7 and 9 DAH respectively. Similarly, the lowest physiological loss in curd weight without jacket leaves recorded in Khumal Jyapu were 10.45%, 14.82%, 22.83% and 29.77% at 3, 5, 7 and 9 DAH respectively. The lowest spoilage losses of curd along with and without jacket leaves recorded in Aghani were 33.27% and 38.77% respectively. Considering the economically important postharvest attributes Khumal Jyapu and Aghani were found to be the suitable mid-season cultivars in Dang condition.

Keywords : Cauliflower, postharvest, open pollinated

Introduction:

Cauliflower (*Brassica oleracea var. botrytis L.*), king of cole crop (Giri, 2020) is an important vegetable widely grown in terai, and mid hills of Nepal (Pradhan et al., 2023 & Giri et al., 2020). Cauliflower is mainly grown for its edible immature curd which contains good source of vitamins and minerals and helps to prevent chronic cancer and cardiovascular diseases (Keck, 2004 & Ara et al., 2009). Cauliflower can be consumed as raw, cooked vegetable, curry and also used as supplement in restaurant in preparation of noodles, burger and sandwich (Ashraf et al., 2017). In the Nepalese scenario cauliflower covers a total area of 39,214 ha and a total production of 611,015 t with the average productivity of 15.58 t/ha. Similarly, in Lumbini province cauliflower is produced in 7086 ha of land with the total production of 114760 t with the productivity of 16.20 t/ha. In addition, Dang covers an area of 465 ha, 8556 t production and productivity of 18.40 t/ha in cauliflower (MOALD, 2021/22).

In Nepal, despite the fact that a large number of varieties and agro-techniques have been developed but the productivity of cauliflower has still not reached the desired level (Pradhan et al., 2023 & Giri et al., 2020). Ndiaga (2000) concluded that different cultivars with different plant morphology would require different optimum environmental conditions to express their full yield potential. The success of most crop improvement programme largely depends upon the genetic variability and the heritability of desirable traits in cauliflower yield (Chatterjee et al., 2018). Varietal differences of

All the authors declares that there is no any conflict of interest.

cauliflower in terms of growth pattern, curd yield and postharvest attributes are extremely diverse from plant to plant, making breeding programs for cauliflower more complex than other crops. Therefore, there is great need for genetic improvement and farmers can attribute development of cauliflower cultivars with acceptable and better traits, which can be achieved through the study of the different growth, yield and postharvest component, which occur in different varieties of cauliflower.

Similarly, in order to increase production, Nepalese farmers are using hybrid cultivars along with the haphazard use of the chemical fertilizers and pesticides. The use of chemical manures and pesticides also affect the postharvest longevity of the curd as they decreased the cellular and sub cellular parts of the curd (Bhattarai & Budhathoki, 2005 & Basnet et. al., 2017).

For better price of cauliflower curd in national and international market, excellent color, compactness of curd, good taste and postharvest longevity are important criteria (Bhattarai & Budhathoki, 2005). Moreover, the main postharvest problems affecting shelf life of cauliflower during marketing are physiological loss in weight, spoilage loss, yellowing of the curd, floret opening, loss of hardness, the development of an undesirable odour, off-flavours and the risk of microbial development (Licciardello et al., 2013 & Zhan et al., 2014). Thus, this experiment is carried out to assess the postharvest and sensory quality performance of best open pollinated cultivars suitable for winter season in Dang condition.

Materials and Methods:

Location of the study

The research was conducted at Tulsipur Sub Metropolitan City, Dang for two years (2021 and 2022 A.D.).

Design of the study

Five OP cauliflower cultivars viz. Kathmandu Local, Khumal Jyapu, Agheni, Terai-1 and Terai-2 (seeds sourced from Nepal Agriculture Research Council, Khumaltar, Lalitpur) were replicated four times in Randomized Complete Block Design in the horticulture farm of Campus of Live Sciences. Freshly harvested curds from the respective plots were considered in the postharvest and sensory study and carried out under laboratory condition at Horticulture Lab of Campus of Live Sciences, Tulsipur, Dang. The laboratory research was laid out in Completely Randomized Design (CRD) with four replications.

Weather parameters of the experimental area (laboratory condition)

The cauliflower curds with and without jacket leaves were stored for 9 days in orders to calculate the physiological loss and spoilage loss. They were stored during December 1 to 9 for both the years 2020 and 2021. The average temperature and relative humidity of the laboratory condition during 9 days of storage was 17.360C and 42.76% respectively on 2021 whereas in 2022 the average temperature and relative humidity of the storage temperature was 17.980C and 43.03% respectively.

Determination of dry matter content of leaf and curd

The leaves and curd were taken for the determination of dry matter content immediately after harvesting on December 1 in two years, 2021 and 2022 A.D. As per Panthi et al. (2020) the harvested curds and leaves from each plot were cut individually and 100 gm sample of leaf and curds were oven dried for 48 hours at 650C in hot air oven (SSU-106 Oven Universal-Memert type, Sanjeev Scientific Udyog, India). The percent dry matter content was calculated by using the formula as;

$$DM = \frac{(Ws-Ds)}{Ws} X\ 100$$

Where, DM = Dry matter (%), Ws = curd sample (gm), Ds= Oven dry sample (gm)

Determination of vitamin c content of curd

The curds were taken for the determination of dry matter content immediately after harvesting on December 1 in two years, 2021 and 2022 A.D. Firstly; 5 ml of working standard solution was prepared by dissolving fresh cauliflower curd sample. Then, 10 ml of 4 % oxalic acid (Fizmerk, Fizmerk India Chemicals, India) added to the standard solution, and titrated against the dye (V1ml) until the appearance of pink color (end-point), thus the amount of dye consumed is equivalent to the amount of ascorbic acid. To make known volume (100 ml), 0.5–5 g sample was extracted on 4 % oxalic acid and centrifuged. Then, 5 ml of supernatant was pipette out (ZI 2066D, Zeal International, India) and 10 ml of 4 % oxalic acid added. It was titrated against the dye (V2 ml) until pink color develops (Basnet et al., 2017). Finally, amount of ascorbic acid (vitamin C) calculated with the following formula:

Amount of ascorbic acid (mg/100 gm of curd) = (1000.5 mg×V2 ml ×100 ml))/(V1 ml ×5ml ×wt.of sample))

V1= Titrated volume of standard solution against dye

V2=Titrated volume of sample solution against dye

Determination of Total Soluble Solid (TSS)

The curds were taken for the determination of TSS immediately after harvesting on December 1 in two years, 2021 and 2022 A.D. The cauliflower curds were ground and the curd juice was kept on prism of Refractometer (RHB 32 ATC, ERMA Refractometer, Japan) to measure TSS in Degree Brix.

Organoleptic test

The curds were taken for the determination of organoleptic test immediately after harvesting on December 1 in two years, 2021 and 2022 A.D. An organoleptic test was conducted by involving 50 personnel to evaluate the

Scale	Colors	Compactness	Appearance	Acceptability
1-3	Poor	Loose	Poor	Acceptable
3-5	Good	Slightly loose	Attractive	Preferred
5-7	Better	Compact	More attractive	More preferred
7-9	Best	Very Compact	Highly attractive	Highly preferred

curd characteristics based on the following parameters and numbering system (Giri et al., 2020).

Physiological loss in weight: After harvesting of the curds on December 1 (2012 and 2022 A.D.) they were taken for physiological loss in weight and were observed up to December 9 (9 days after harvesting of the curd). Jacket leaves here means the marketable leaves attached along with the curd. The physiological loss in weight (PLW) of randomly selected five sample curds with and without their jacket leaves were examined by keeping them in normal room condition for nine days (Basnet et al., 2017). PLW was calculated by using following formula:

$$PLW = \frac{\text{Intial weight-Fresh weight of the sample}}{\text{Initial weight of the sample)}} \times 100$$

Spoilage loss: After harvesting of the curds they were taken for spoilage loss and were observed up to 9 days after harvesting of the curd. The spoilage loss of randomly selected five sample curds with and without their jacket leaves were examined by keeping them in ordinary room condition for nine days (Basnet et al., 2017). It was calculated by using following formula:

$$\text{Spoilage (\%)} = \frac{\text{Weight of the spoiled curds}}{\text{Original weight of the curd}} \times 100$$

Statistical analysis: Genestat for Teaching and Learning (18th Edition) was used for the analysis of variance and other data analysis. Means were compared using Duncan's Multiple Range Test (DMRT) at 0.05 and 0.01 level of significance.

Results:

Biochemical parameters of cauliflower

The percentage curd dry matter (15.91%) and vitamin c content (37.94 mg/100 gm) was found to be significantly highest in Khumal Jyapu and lowest i.e. 7.31% curd dry matter and 37.58 mg/100 gm Vitamin C in Kathmandu Local cultivars grown at Dang condition. Similarly, Aghani cultivar showed the significant results with maximum leaf dry matter (12.53%) and TSS (7.183^0Brix) whereas lowest leaf dry matter (7.31%) was found in Kathmandu Local and TSS (5.3730 Brix was found in Terai-1 cultivars (Table 1).

Organoleptic test and sensory evaluation

The color score (8.913) and appearance score (7.908) was found to be significantly highest in Khumal Jyapu whereas compactness score (7.475) and acceptance score (8.133) was found to be significantly highest in Aghani cultivars of cauliflower. In addition, Teari-1 showed the lowest score in relation to color (6.025), compactness (5.823), appearance (5.480) and acceptance (6.723) parameters (Table 2).

Physiological loss in weight of cauliflower with jacket leaves

Physiological loss in weight of curd with jacket leaves of cauliflower during storage period showed significant results (Table 3). The lowest physiological loss in weight was recorded to be 8.193% in Khumal Jyapu cultivars at 3 days after harvesting (DAH) whereas, Aghani showed significantly the lowest physiological loss in weight i.e. 13.47%, 19.32% and 25.06% at 5, 7 and 9 DAH respectively. Moreover, Kathmandu Local showed significantly the highest physiological loss in weight i.e. 14.03%, 19.34%, 24.71% and 30.59% at 3, 5, 7 and 9 DAH respectively (Table 3).

Physiological loss in weight of cauliflower without jacket leaves

Physiological loss in weight of curd without jacket leaves of cauliflower during storage period showed significant results. The lowest physiological loss in weight recorded in Khumal Jyapu were 10.45%, 14.82%, 22.83% and 29.77%. at 3, 5, 7 and 9 days after harvesting (DAH) respectively. Aghani is at par with Khymal Jyapu in PLW in all dates except in 3 DAH. Kathmandu Local showed significantly the highest physiological loss in weight of curd without jacket leaves i.e. 15.53%, 21.88%, 29.02% and 35.37% at 3, 5, 7 and 9 DAH respectively (Table 4).

Spoilage loss in cauliflower with and without jacket leaves

Spoilage loss in relation to jacket leaves and without jacket leaves gave the significant results. The lowest spoilage loss along with and without jacket leaves was recorded to be 33.27% and 38.77% respectively in Aghani cultivars followed by Khumal Jyapu, whereas the highest spoilage loss was found in Terai-1 cultivars with and without jacket leaves i.e. 42.32% and 48.58% respectively (Table 5).

Discussion:

Biochemical parameters of cauliflower

The curd and leaf dry matter percent, vitamin c content and TSS were found to be significant on various open pollinated cultivars of cauliflower. The variation of these biochemical parameters might be due to both genetic and environmental influences such as nutrient source,

Table 1 : Mean leaf dry matter, curd dry matter, TSS and vitamin c of different open pollinated cauliflower genotypes immediately after harvesting in Tulsipur, Dang for two years (2021 to 2022 AD)

Treatments	Leaf dry matter (%)	Curd dry matter (%)	TSS (^{0}Brix)	Vitamin C (mg/100 gm)
Terai-1	9.89^c	15.52^a	5.373^a	36.63^a
Aghani	12.53^d	15.71^a	7.183^b	37.89^b
Terai-2	8.80^b	15.47^a	6.285^{ab}	36.77^a
Khumal Jyapu	12.14^d	15.91^a	6.818^b	37.94^b
Kathmandu Local	7.31^a	14.31^a	6.393^b	37.58^b
Grand mean	10.1	15.4	6.4	37.4
SEM	0.21	0.42	0.23	0.18
F-test	**	NS	**	**
$LSD_{0.05}$	0.60	1.21	0.67	0.51
CV %	5.8	7.7	10.2	1.3

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

Table 2 : Mean color, compactness, appearance, and acceptance of different open pollinated cauliflower genotypes immediately after harvesting in Tulsipur, Dang for two years (2021 to 2022 AD)

Treatments	Color (1-9)	Compactness (1-9)	Appearance (1-9)	Acceptance (1-9)
Terai-1	6.025a	5.823a	5.480a	6.723a
Aghani	7.913c	7.475c	7.062bc	8.133b
Terai-2	6.820ab	6.351ab	6.501b	6.740a
Khumal Jyapu	8.193c	7.328c	7.908c	8.058b
Kathmandu Local	7.674bc	6.924bc	7.636c	6.954a
Grand mean	7.3	6.8	6.9	7.3
SEM	0.21	0.14	0.24	0.19
F-test	**	**	**	**
LSD0.05	0.60	0.40	0.68	0.56
CV %	8.0	5.8	9.6	7.4

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

Table 3 : Mean physiological loss in weight with jacket leaves of different open pollinated cauliflower genotypes in Tulsipur, Dang for two years (2021 to 2022 AD)

Treatments	Physiological loss in weight of curd with jacket leaves (%)			
	3 DAH	5 DAH	7 DAH	9 DAH
Terai-1	12.49^b	17.11^c	20.77^b	27.18^b
Aghani	9.52^a	13.47^a	19.32^a	25.06^a
Terai-2	10.42^a	15.76^b	22.58^c	28.75^c
Khumal Jyapu	8.75^a	14.14^a	19.79^a	25.81^a
Kathmandu Local	14.03^b	19.34^d	24.71^d	30.59^d
Grand mean	11.0	16.0	21.4	27.5
SEM	0.45	0.19	0.16	0.19
F-test	**	**	**	**
LSD0.05	1.31	0.78	0.47	0.55
CV %	2.7	3.4	2.1	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, CV = Coefficient of variance

Table 4 : Mean physiological loss in weight with jacket leaves of different open pollinated cauliflower genotypes in Tulsipur, Dang for two years (2021 to 2022 AD)

Treatments	Physiological loss in weight of curd without jacket leaves (%)			
	3 DAH	5 DAH	7 DAH	9 DAH
Terai-1	14.58^{d}	18.01^{b}	26.91^{c}	32.12^{b}
Aghani	11.54^{b}	15.22^{a}	22.99^{a}	30.37^{a}
Terai-2	12.71^{c}	17.62^{b}	24.80^{b}	35.31^{c}
Khumal Jyapu	10.45^{a}	14.82^{a}	22.83^{a}	29.77^{a}
Kathmandu Local	15.53^{d}	21.88^{c}	29.02^{d}	35.37^{c}
Grand mean	13.0	17.5	25.3	32.6
SEM	0.25	0.42	0.18	0.36
F-test	**	**	**	**
LSD0.05	0.73	1.22	0.52	1.03
CV %	5.5	3.8	2.0	3.1

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

Table 5 : Mean spoilage loss with and without jacket leaves of different open pollinated cauliflower genotypes in Tulsipur, Dang for two years (2021 to 2022 AD)

Treatments	Spoilage loss in curd (%)	
	With jacket leaves	Without jacket leaves
Terai-1	42.32^{e}	48.58^{d}
Aghani	33.27^{a}	38.77^{b}
Terai-2	40.29^{d}	45.91^{c}
Khumal Jyapu	34.57^{b}	40.10^{b}
Kathmandu Local	37.96^{c}	47.72^{d}
Grand mean	37.7	44.2
SEM	0.25	0.31
F-test	**	**
LSD0.05	0.72	0.89
CV %	1.9	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, CV = Coefficient of variance

climatic condition, soil fertility status, as similar finding was mentioned by Abbey et al. (2002), Giri (2020) and Giri et al. (2020).

Organoleptic test and sensory evaluation

The scoring in terms of color, compactness, appearance and acceptance showed the significant results in open pollinated cultivars of cauliflower. The significant variation found in various cauliflower cultivars, might be due to genetic characteristics of the varieties (Giri et al., 2020). Moreover, Sharma et al. (2018) & Pun et al. (2003) also observed the significant differences on color, compactness, appearance and acceptance on different varieties of cauliflower. Meena et al. (2010) also observed the similar differences on cabbage crop.

Physiological and spoilage loss in weight of cauliflower with and without jacket leaves

The physiological loss and spoilage loss in weight of cauliflower was found to be significant both with and without jacket leaves. This variation on physiological loss in weight and spoilage loss in cauliflower curd among different late season cauliflower varieties was also observed by Giri (2020), Giri et al. (2020), Yadav et al. (2013), Kumar et al. (2011); Kido & Singh (2018).

Growth parameter, yield parameter, postharvest parameter and sensory quality parameters of different cauliflower genotypes differed significantly with each other. However, the same growing condition might have different variation in different open pollinated cauliflower cultivars might be due to different characteristics of genotypes governed by different genes which are greatly influenced by environmental factors and management practices (Khanal et. al., 2022). Similar results were reported by Poudel et. al. (2017); Khatiwada &

Chaudhary (2004); Budhathoki et al. (2004) in different varieties of cauliflower.

Conclusion:

It was found that the biochemical parameters such as TSS and vitamin c, leaf and curd dry matter; organoleptic taste and sensory evaluation, physiological loss in weight and spoilage loss both with and without jacket leaves were significantly different in different open pollinated cauliflower cultivars. The percentage curd dry matter (15.91%) and Vitamin C content (37.94 mg/100 gm) was found significantly highest in Khumal Jyapu whereas, maximum leaf dry matter (12.53%) and TSS (7.1830Brix) were recorded in Aghani. The color and overall appearance score was maximum in Khumal Jyapu whereas, curd compactness and overall acceptance score was maximum in Aghani. The lowest physiological loss in curd weight with jacket leaves was recorded in Khumal Jyapu after 3 days after harvesting (DAH) whereas; the lowest physiological loss in curd weight recorded in Aghani at 5, 7 and 9 DAH respectively. Similarly, the lowest physiological loss in curd weight without jacket leaves recorded in Khumal Jyapu at 3, 5, 7 and 9 DAH respectively. The lowest spoilage losses of curd along with and without jacket leaves recorded in Aghani followed by Khumal Jyapu. Considering the economically important postharvest attributes, Khumal Jyapu and Aghani were found to be the suitable cultivars to grow in Dang and similar mid hill condition of Nepal.

Acknowledgement(s):

The authors would like to acknowledge Province Planning Commission, Lumbini province for providing the research grant and Campus of Live Sciences, Tulsipur, Dang for providing field and laboratory arrangement to conduct this study.

Declaration of conflict of interest and ethical approval:

We declare no conflict of interest regarding publication of this manuscript.

References:

Abbey, L., Joyce, D.C., Aked, J., & Smith, B. (2002). Genotype, sulfur nutrition and soil type effects on growth and dry-matter production of spring onion. The Journal of Horticultural Science and Biotechnology, 77(3), 340-345. DOI: http://dx.doi.org/10.1080/14620316.2002.11511503

Ara N, Kaisar, M.O., Khalequzzaman, K.M., Kohinoor, H., & Ahamed, K.U. (2009). Effect of different dates of planting and lines on the growth, yield and yield contributing characteristics of cauliflower. Journal of Soil Nature, 3(1):16-19.

Ashraf, M.I., Sajad, S., Hussain, B., Sajjad, M., Saeed, M.S., Sattar, S., & Iqbal, M.A. (2017). Physiological attributes of cauliflower (*Brassica oleracea var. botrytis L.*) as influenced by the application of different levels of nitrogen and hand weeding. International Journal of Pure and Applied Bioscience, 5(6): 9-13. DOI: http://dx.doi.org/10.18782/2320-7051.6000

Basnet, M., Shakya, S.M., & Baral, B.R. (2017). Response of organic manures on post harvest and soil nutrient restoration on cauliflower production. The Journal of Agriculture and Environment, 18, 67-72. DOI: http://dx.doi.org/10.3126/aej.v18i0.19891

Bhattarai, D.R., & Budhathoki, K. (2005). Effect of organic manures on pre and post harvest physiology and consumers' acceptability of cauliflower (Brassica oleracea var. botrytis L). Nepal Journal of Science and Technology, 6, 11- 14.

Budathoki, K., Pradhan, N.G., & Bhattarai, D.R. (2004). Evaluation of cauliflower varieties for off-season production in the mid hills of Nepal. Fourth national workshop on horticulture, March 2-4; 407-417.

Chatterjee, S, Aralikatti, O., Sharma, S., Mukherjee, D., Patil, S., Kanwar, H.S., & Choudhuri, P. (2018). Studies of genetic variability, heritability and genetic gain for some important horticultural traits in cauliflower (*Brassica oleracea var. botrytis L.*) International Journal of Current Microbiology and Applied Sciences,7, 83-92. DOI: https://doi.org/10.20546/ijcmas.2018.704.010

Giri, H.N. (2020). Growth, yield and postharvest quality of late season varieties of cauliflower at Rampur, Chitwan. Journal of Agriculture and Forestry University, 4, 169-175.

Giri, H.N., Sharma, M.D., Thapa, R.B., Pande, K.R., & Khatri, B.B. (2020). Performance on postharvest quality of late season cauliflower (*Brassica oleracea var. botrytis L.*) varieties in terai region of Nepal. Archives of Agriculture and Environmental Science, 5(4), 543-547. DOI: https://doi.org/10.26832/24566632.2020.0504017

Keck, A. S. (2004). Cruciferous vegetables: Cancer protective mechanisms of glucosinolate hydrolysis products and selenium. Integrative Cancer Therapies, 3, 5-12. DOI: 10.1177/1534735403261831.

Khanal, A., Timilsina, S., Khanal, S., & Timilsina, C. (2022). Performance of different varieties of mid-season cauliflower at Jaljala, Parbat. Proceedings of 14th National Outreach Research Workshop, 22 & 23 Feb., 2022, Khumaltar, Lalitpur, Nepal; 147-151.

Khatiwada, P.P., & Chaudhary, B.P. (2004). Effect of planting dates and plant spacing on late season (march-may) cauliflower production. Fourth national workshop on horticulture, March 2-4; 328-333.

Kumar, M., Sharma, S.R., Kalia, P. & Saha, P. (2011). Genetic variability and character association for

quantitative and quality traits in early maturing Indian cauliflowers. Indian Journal of Horticulture, 68(2), 206-211. DOI: https://www.researchgate.net/journal/Indian-Journal-of-Horticulture-0974-0112

Licciardello, F., Muratore, G., Spagna, G., Branca, F., Ragusa, L., & Caggia C. (2013). Evaluation of some quality parameters of minimally processed white and violet pigmented cauliflower curds. Acta Horticulturae, 1005, 301-308. DOI: https://doi.org/10.17660/ActaHortic.2013.1005.34

Meena, M.L., Ram, R.B., Lata, R. & Sharma, S.R. (2010). Determining yield components in cabbage (Brassica oleracea var. capitata L.) through correlation and path analysis. International Journal of Science and Nature, 1(1), 27-30.

MoALD. (2022). Statistical information on nepalese agriculture. Agri-business Promotion and Statistics Division, MoAD, Singha Durbar, Kathmandu, Nepal.

Ndiaga, C. (2000). Genotype x Row Spacing and Environment interaction of cowpea in semi-arid zones. African Crop Science Journal, 9(2): 359-367. DOI: https://doi.org/10.4314/acsj.v9i2.27606

Panthi, J, Shrestha, R.K., Shrestha, S., Manandhar, B.D., Bhatta, N.P., & Devkota, S. (2020). Response of cauliflower (Brassica oleraceae var. botrytis L.) to different level of boron under maize based cropping system. Journal of Institute of Agriculture and Animal Science, 36, 231-240.

Poudel, K., Ansari, A.R., & Shah, M.K. (2017). Varietal evaluation of cauliflower for early season production in the eastern hills of Nepal. In: IP Gautam, SL Shrestha, GD Subedi, DR Bhattarai, TP Gotame and KP Upadhyay eds. Proc. of 9th National Horticulture Workshop, May 31-June 1, 2017, NARC, HRD, Khumaltar, Lalitpur, Nepal; 316-319.

Pradhan, N.G., Srivastava, A., Shrestha, A.K., & Gautam, I.P. (2023). Evaluation of cauliflower genotypes to different planting dates for early production in Kathmandu valley. Nepal Agriculture Research Journal, 15(1), 82-97. DOI: http://dx.doi.org/10.3126/narj.v15i1.51320

Pun, A.B., Pandey, Y.R. & Yadav, Y.P. (2003). Performance of cauliflower varieties under different agro-ecological domains of western hills of Nepal. Agricultural research for enhancing livelihood of Nepalese people. In: proc. 2nd SAS-N convention, 30 July-1 August 2003, pp: 235-238.

Sharma, S., Singh, Y., & Sharma, S. (2018). Studies on mean performance for yield and its contributing traits in cauliflower (*Brassica oleracea var. botrytis L.*) under mid hill conditions of northwestern Himalayas. International Journal of Current Microbiology and Applied Science, 7(2), 3288-3296. DOI: http://dx.doi.org/10.20546/ijcmas.2018.702.395

Yadav, M., Prasad, V.M., & Ahirwar, C.S. (2013). Varietal evaluation of cauliflower (*Brassica oleracea var. botrytis L.*) in Allahabad agro-climatic condition. Trends in Biosciences, 6(1), 99-100.

Zhan, L. Jinquiang, Hu., Pang, L., Li. Yu., & Shao, J. (2014). Light exposure reduced browning enzyme activity and accumulated total phenols in cauliflower heads during cool storage. Postharvest Biology and Technology, 88, 17-20. DOI: https://doi.org/10.1016/j.postharvbio.2013.09.006