

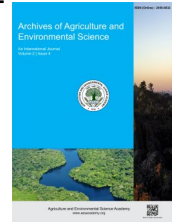


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ORIGINAL RESEARCH ARTICLE



## Growth yield performance of different hybrid cauliflower (*Brassica oleraceae* var. *botrytis* L.) cultivars in Dang, Nepal

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### ABSTRACT

Cauliflower is commonly grown in terai and mid-hills during the winter season (September to December), thus known as mid-season cole crop in the context of Nepal. As this cropping period possess favorable environmental condition to grow, and the production cost is comparatively lower and productivity is higher as compared to early and late seasons crop. Farmers are cultivating various hybrid (F1) cultivars to increase the yield and income. Every year, several hybrids are being imported in Nepal and there needs a varietal trial before being recommended at farmer's field. Thus, this experiment was conducted at horticulture farm of Campus of Live Sciences, Tulsipur, Dang, Nepal for two consecutive years (2021 and 2022 AD) to evaluate the growth and yield attributes of five hybrid cauliflower cultivars. Cultivars viz. Snow Best, Snow Crown, Super White Top, Rami and Damy were treated as treatment and replicated four times in Randomized Complete Block Design. The experiment showed that cultivar Super White Top and Snow Crown had desirable vegetative characteristics, better yield, and higher harvest index as compared to other cultivars. Hence, Super White Top and Snow Crown could be promoted for cultivation in the agro climatic zones related to that of Tulsipur, Dang. Considering the economically important growth and yield attributes Super White Top and Snow Crown were found to be the suitable mid-season hybrid cultivars in Dang condition.

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### INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) also known as king of Cole crop belongs to Brassicaceae family (Giri, 2020). It is an important commercial vegetable crop in Nepal which is grown from terai to mid hills of Nepal (Pradhan *et al.*, 2023; Khanal *et al.*, 2022; Giri *et al.*, 2020). The economical and edible part of cauliflower is immature curd and is rich source of several vitamins, minerals and fiber (Poudel *et al.*, 2017). Cauliflower serves medicinal value as it helps to prevent chronic cancer and cardiovascular diseases (Keck & Finley, 2004; Ara *et al.*, 2009) and is consumed as raw, cooked vegetable, curry and is the best ingredients in noodles, burgers and sandwich preparation (Sajad, 2017; Kushwah *et al.*, 2023). In the world, cauliflower is

cultivated in a total area of 1226455 ha of land with total production of 6822153522 mt and productivity of 18.1 mt/ha (FAO, 2023). Cauliflower ranked first in terms of area and production among vegetables in Nepal with a total area of 39,214 ha and a total production of 611,015t with the average productivity of 15.58 t/ha (MoALD, 2020).

Majority of the Nepalese farmers grow cauliflower in mid-season (September to December) because of favorable environmental condition, low cost of production and higher yield as compared to early and late season. The productivity of cauliflower in Nepal is pretty less as compared to globe productivity so that the Nepalese farmers are using several hybrid cultivars to boost up their production and productivity. Thus, the hybrid seeds' import in context of Nepal has shoot up

drastically since the past few years. The cauliflower yield differs in different growing regions (Bhattarai et al., 2014) and is governed by the varietal characteristics along with the environment conditions (Cisse, 2001; Shrestha, 2022). Cauliflower with superior traits i.e. productivity, postharvest quality (color, compactness, taste and postharvest longevity of the curd) and resistance to biotic and abiotic factors are essential for higher yield (Khanal et al., 2022; Bhattarai & Budhathoki, 2005). Similarly, farmers are using the hybrid cultivars haphazardly without varietal and location trial by which the productivity of cauliflower has not increased to desired level (Pradhan et al., 2023; Giri et al., 2020). So, this study was carried out to identify the suitable hybrid cultivars for mid-season planting in the Dang, western mid-hill of Nepal.

## MATERIALS AND METHODS

### Location and agro climate of the experimental site

The field experiment was conducted at horticulture farm of Campus of Live Sciences, Tulsipur, Dang at an altitude of 750 m for two continuous cauliflower growing season of 2021 and 2022. The experimental site lies in the Terai geographical region of with the latitude and longitude of 28°15'45" N, 82°32'35" E. Weekly average data of maximum and minimum temperature, total rainfall during cauliflower growing period was collected from Tulsipur Sub metropolitan City office, Tulsipur, Dang. The average temperature and relative humidity of the cropping season during 2021 was 21.22 °C 78.09% whereas, the average temperature and relative humidity of the cropping season during 2022 was and 21.09°C and 77.89%, respectively (Figure 1).

### Design of the study

Five hybrid cauliflower cultivars viz. Snow Best, Snow Crown, Super White Top, Rami and Damy (seeds collected from registered agriculture shop) were replicated four times in randomized complete block design (RCBD) in the horticulture farm of Campus of Live Sciences, Dang, Nepal. There was a total of 20 plots. Individual net experimental plot area comprised of 3 m×2.5 m (7.5 m<sup>2</sup>) with 25 plants. Cauliflowers were planted at a spacing of 60×50 cm. There were a total 500 pants including the

boarder plants in the plots. The space between blocks and plots were 1 m and 0.5 m, respectively.

### Nursery raising, land preparation, transplanting, and fertilization

Nursery tray and peat moss was used for nursery rising of the cauliflower. The experimental field was ploughed thoroughly up to 25-30 cm depth was done and full dose of farm yard manure i.e., 30 tons was applied one month before transplanting of the seedling. Four-week-old seedlings were transplanted in the experimental field. The recommended dose of fertilizer for cauliflower i.e. 30 t Farm Yard Manure (FYM) and 200:120:80 Nitrogen (N), Phosphorous (P) and Potassium (K) kg/ha (Giri, 2020) was applied. Full dose of P and K and half dose of N were applied during transplanting day whereas, half of the nitrogen was applied after 30 days after transplanting. Similar inter-cultural operations (weeding, irrigation, pesticide application) were carried out in all experimental plots.

### Observations taken

Plant height was measured from the ground level to the growing point in five tagged plants of each plot. Stem diameter (basal portion of the stem) from the five tagged plants of each plot was measured with the help of Vernier's Caliper. Effective leaf numbers were counted in five tagged plants from each plot. Length of leaf in the plant was measured from the base of the leaf tip and width of the leaf was also measured in five selected plants. Diagonal length and width at top surface of the plant representing the plant coverage was measured from the selected five plants. The observation for plant height, stem diameter, leaf number, rosette diameter, length and width of the leaf were recorded at 25, 40, 55 days after transplantation (DAT) and harvesting day, later the mean was calculated. The days to curd initiation and curd maturity of five tagged plants were recorded from the date of transplanting and means were calculated. At the time of harvesting, fresh weight of leaves and stem per plant were recorded with the help of spring balance. Similarly, the height and diameter of the curds from five selected experimental plants were recorded at the time of harvesting with the help of meter scale. The total weight of curd, roots, stem and leaves immediately after harvest was recorded from five experimental plants as biological yield whereas, economic yield was calculated as total curd yield along with 3-4 inner jacket leaves. The net plot yield was then converted to ton ha<sup>-1</sup>. Harvest index was calculated as (Dhakal et al., 2009).

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (curd yield)}}{\text{Total biological yield}} \times 100$$

### Statistical analysis

Data was systematically arranged on the basis of various observed parameters. The analysis of variance (ANOVA) was done using IBM SPSS statistics V.27. Means were compared using Duncan's Multiple Range Test (DMRT) at 0.05 and 0.01 level of significance.

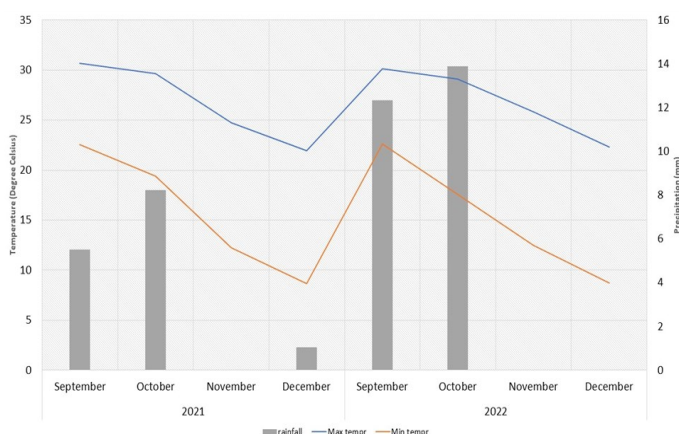


Figure 1. Agro climatic parameters (rainfall, maximum temperature, minimum temperature, and relative humidity) during crop season.

## RESULTS AND DISCUSSION

### Growth attributes

**Plant height and stem diameter:** The combined analysis of variance showed that plant height was significant at 55 days after transplanting (DAT) and at harvest stage of the crop whereas, stem diameter was found to be significant at 40, 55 DAT and at harvest stage of the cauliflower. The mean separation showed, Rami variety had a consistence higher plant height at 25, 40 and 55 DAT while Super White Top cultivar had the highest plant height at harvest stage of the crop. Similarly, Super White Top had the highest stem diameter at 25, 55 DAT and at harvest stage of the crop whereas Rami cultivar had the highest stem diameter at 40 DAT. The mean plant height of various cauliflower cultivars at 25, 40, 55 DAT and harvest stage was found to be 17.1 cm, 26.1 cm, 43.7 cm, and 49.7 cm, respectively (Table 1). Moreover, the grand mean of stem diameter at 25, 40, 55 DAT and harvest stage was 0.6 cm, 0.9 cm, 1.5 cm, and 1.8 cm, respectively. The maximum variation on both plant height and stem diameter was observed at mid growth state (55 DAT). The variation in plant height and stem diameter of cauliflower among different cultivars is due to genetic characteristics and environmental factors (Giri, 2020; Giri et al., 2020). Similar results were reported by (Santhosha et al., 2014; Jindal & Thakur, 2004; Chittora and Singh, 2015; Giri et al., 2023; Shrestha, 2022).

**Leaf attributes:** Combined analysis of variance revealed a significant variation on leaf number at 25, 55 DAT and at harvest stage and leaf length also found to be significant across 25, 40, 55 DAT and at harvest stage of crop. In addition, leaf breath was found to be significant across 40, 55 DAT and at harvest stage of crop. Damy cultivar showed highest leaf number at 25 DAT,

Rami cultivar had the highest leaf number across 40 and 55 DAT while, Super White Top had the highest leaf number at harvest stage of crop. Similarly, the highest leaf length was observed in Rami at 25 DAT whereas, Super White Top had at 40, 55 DAT and at harvest stage of the crop. The highest leaf breadth was observed in Rami across 25, 40 and 55 DAT while, Snow Crown had at harvest stage of the crop during its overall growth period. The maximum variation among cauliflower cultivars for leaf number, leaf length, and leaf breadth was observed at 55 DAT. The variation in leaf number, length and breadth of cauliflower among different cultivars is due to genetic characteristics and environmental factors (Giri et al., 2020; Ram et al., 2009; Yadav et al., 2013). The similar leaf attributes (leaf number, breadth and width) variation was found in different hybrid cauliflower cultivars (Giri et al., 2023; Kindo & Singh, 2018; Shrestha, 2022).

**Rosette diameter:** The combined analysis of variance revealed a significant variation on rosette diameter of hybrid cultivars across 40, 55 DAT and at harvest stage of the crop as well. Super White Top cultivar showed the highest rosette diameter across 40 and 55 DAT while, Rami had at 25 DAT and harvest stage of crop. The mean rosette diameter at 25, 40, 55, and harvest stage was 19.5 cm, 31.9 cm, 56.9 cm, 60.2 cm, respectively and the maximum variation was observed at 55 DAT. Moreover, Super White Top cultivar showed the highest fresh stem weight (85.92 gm) and fresh leaf weight (683.7 gm) among the other hybrids. The variation in rosette diameter, fresh stem and leaf weight of cauliflower among different cultivars is due to genetic characteristics and environmental factors (Giri et al., 2020; Poudel et al., 2017; Pandey, 2003). The similar results was found by (Giri et al., 2023; Rai & Kencho, 2024; Kindo & Singh, 2018; Shrestha, 2022).

**Table 1.** Mean plant height and stem diameter of different hybrid cauliflower cultivars at periodic stages of growth in Tulsipur, Dang during September to December month of 2021 and 2022.

Cultivars	Plant height (cm)				Stem diameter (cm)			
	25 DAT	40 DAT	55 DAT	Harvest	25 DAT	40 DAT	55 DAT	Harvest
Snow Best	16.39 <sup>a</sup>	25.04 <sup>a</sup>	39.35 <sup>a</sup>	42.09 <sup>a</sup>	0.535 <sup>a</sup>	0.8288 <sup>a</sup>	1.505 <sup>ab</sup>	1.767 <sup>a</sup>
Snow Crown	15.87 <sup>a</sup>	26.32 <sup>a</sup>	41.84 <sup>a</sup>	49.44 <sup>bc</sup>	0.5575 <sup>ab</sup>	0.8813 <sup>ab</sup>	1.483 <sup>ab</sup>	1.778 <sup>a</sup>
Super White Top	17.51 <sup>a</sup>	27.29 <sup>a</sup>	47.38 <sup>b</sup>	55.55 <sup>d</sup>	0.6629 <sup>b</sup>	0.97 <sup>bc</sup>	1.652 <sup>ab</sup>	1.896 <sup>a</sup>
Rami	18.26 <sup>a</sup>	27.39 <sup>a</sup>	47.61 <sup>b</sup>	53.62 <sup>cd</sup>	0.6469 <sup>b</sup>	1.035 <sup>c</sup>	1.364 <sup>a</sup>	1.847 <sup>a</sup>
Damy	17.42 <sup>a</sup>	24.41 <sup>a</sup>	42.22 <sup>a</sup>	47.72 <sup>b</sup>	0.5916 <sup>ab</sup>	0.8538 <sup>ab</sup>	1.343 <sup>a</sup>	1.907 <sup>a</sup>
Grand mean	17.1	26.1	43.7	49.7	0.6	0.9	1.5	1.8
SEM	0.66	1.27	1.18	1.29	0.03	0.03	0.06	0.05
F-test	NS	NS	**	**	NS	**	**	NS
LSD <sub>0.05</sub>	1.90	3.67	3.43	3.74	0.07	0.09	0.17	0.14
CV %	10.9	13.7	7.6	7.3	12.1	9.3	11.3	7.5

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 leaf number, leaf length and breadth of different hybrid cauliflower cultivars at periodic stages of growth in Tulsipur, Dang during September to December month of 2021 and 2022.

Cultivars	Leaf number				Leaf length (cm)				Leaf breadth (cm)			
	25 DAT	40 DAT	55 DAT	Harvest	25 DAT	40 DAT	55 DAT	Harvest	25 DAT	40 DAT	55 DAT	Harvest
Snow Best	4.445 <sup>a</sup>	6.461 <sup>a</sup>	10.05 <sup>ab</sup>	11.68 <sup>a</sup>	14.03 <sup>ab</sup>	21.01 <sup>a</sup>	34.47 <sup>a</sup>	37.94 <sup>a</sup>	8.057 <sup>a</sup>	9.60 <sup>a</sup>	17.59 <sup>a</sup>	16.96 <sup>a</sup>
Snow Crown	4.726 <sup>ab</sup>	7.240 <sup>a</sup>	9.10 <sup>a</sup>	13.33 <sup>ab</sup>	13.74 <sup>a</sup>	21.80 <sup>ab</sup>	35.98 <sup>a</sup>	41.86 <sup>ab</sup>	7.431 <sup>a</sup>	12.01 <sup>ab</sup>	19.06 <sup>ab</sup>	21.42 <sup>b</sup>
Super White Top	5.071 <sup>ab</sup>	7.136 <sup>a</sup>	11.31 <sup>bc</sup>	15.29 <sup>b</sup>	15.89 <sup>ab</sup>	26.17 <sup>c</sup>	43.54 <sup>b</sup>	48.58 <sup>c</sup>	7.890 <sup>a</sup>	10.96 <sup>ab</sup>	20.24 <sup>b</sup>	20.27 <sup>b</sup>
Rami	4.919 <sup>ab</sup>	7.385 <sup>a</sup>	11.88 <sup>c</sup>	13.63 <sup>ab</sup>	16.14 <sup>b</sup>	25.73 <sup>bc</sup>	42.59 <sup>b</sup>	46.38 <sup>bc</sup>	8.389 <sup>a</sup>	13.74 <sup>b</sup>	20.87 <sup>b</sup>	20.71 <sup>b</sup>
Damy	5.416 <sup>b</sup>	7.326 <sup>a</sup>	11.31 <sup>bc</sup>	14.78 <sup>ab</sup>	14.29 <sup>ab</sup>	20.41 <sup>a</sup>	37.95 <sup>a</sup>	41.95 <sup>ab</sup>	7.814 <sup>a</sup>	11.35 <sup>ab</sup>	20.38 <sup>b</sup>	20.55 <sup>b</sup>
Grand mean	4.9	7.1	10.7	13.7	14.8	23	38.9	43.3	7.9	11.5	19.6	20
SEM	0.2	0.24	0.4	0.49	0.53	1.03	1.07	1.26	0.41	0.8	0.62	0.49
F-test	*	NS	**	**	**	**	**	**	NS	*	**	**
LSD <sub>0.05</sub>	0.59	0.68	1.15	1.42	1.53	2.98	3.11	3.67	1.2	2.32	1.8	1.41
CV%	11.7	9.4	10.4	10.1	10.1	12.6	7.8	8.2	14.8	19.6	8.9	6.9

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 rosette diameter, fresh stem and leaf weight of different hybrid cauliflower cultivars at periodic stages of growth in Tulsipur, Dang during September to December month of 2021 and 2022.

Cultivars	Rosette diameter (cm)				Fresh stem weight (gm)	Fresh leaf weight (gm)
	25 DAT	40 DAT	55 DAT	Harvest		
Snow Best	18.41 <sup>a</sup>	24.96 <sup>a</sup>	50.12 <sup>a</sup>	44.35 <sup>a</sup>	65.09 <sup>a</sup>	562.4 <sup>ab</sup>
Snow Crown	18.33 <sup>a</sup>	32.79 <sup>ab</sup>	54.42 <sup>ab</sup>	64.49 <sup>b</sup>	69.67 <sup>a</sup>	504 <sup>a</sup>
Super White Top	20.65 <sup>a</sup>	36.69 <sup>b</sup>	64.09 <sup>b</sup>	62.19 <sup>b</sup>	85.92 <sup>a</sup>	683.7 <sup>b</sup>
Rami	21.18 <sup>a</sup>	34.94 <sup>b</sup>	60.97 <sup>bc</sup>	67.77 <sup>b</sup>	84.95 <sup>a</sup>	560.7 <sup>ab</sup>
Damy	18.77 <sup>a</sup>	30.34 <sup>ab</sup>	54.81 <sup>ab</sup>	62.35 <sup>b</sup>	72.98 <sup>a</sup>	549.6 <sup>a</sup>
Grand mean	19.5	31.9	56.9	60.2	75.7	572.1
SEM	0.98	2.40	1.83	3.46	5.82	32.17
F-test	NS	*	**	**	NS	**
LSD <sub>0.05</sub>	2.84	6.97	5.31	10.03	16.88	93.35
CV%	14.2	21.3	9.1	16.2	21.7	15.9

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 curd height, curd diameter, biological yield, economic yield and harvest index of different hybrid cultivars in Tulsipur, Dang during September to December month of 2021 and 2022.

Cultivars	No of days to curd		Curd (cm)		Yield (mt/ha)		Harvest index (%)
	Initiation	Maturity	Height	Diameter	Biological	Economic	
Snow Best	47.75 <sup>c</sup>	75.75 <sup>a</sup>	7.54 <sup>a</sup>	12.97 <sup>a</sup>	38.05 <sup>a</sup>	17.50 <sup>a</sup>	46.23 <sup>a</sup>
Snow Crown	45.78 <sup>bc</sup>	74.25 <sup>a</sup>	8.93 <sup>ab</sup>	14.96 <sup>ab</sup>	40.68 <sup>a</sup>	23.60 <sup>bc</sup>	58.14 <sup>b</sup>
Super White Top	45.00 <sup>bc</sup>	75.88 <sup>a</sup>	10.20 <sup>ab</sup>	18.17 <sup>c</sup>	51.67 <sup>c</sup>	27.41 <sup>c</sup>	53.08 <sup>ab</sup>
Rami	43.00 <sup>ab</sup>	75.62 <sup>a</sup>	13.24 <sup>c</sup>	17.34 <sup>bc</sup>	48.71 <sup>bc</sup>	23.27 <sup>b</sup>	47.95 <sup>a</sup>
Damy	40.75 <sup>a</sup>	75.38 <sup>a</sup>	11.47 <sup>bc</sup>	17.15 <sup>bc</sup>	46.02 <sup>b</sup>	22.45 <sup>b</sup>	49.01 <sup>ab</sup>
Grand mean	44.5	75.4	10.3	16.1	45.00	22.8	50.9
SEM	0.90	0.71	0.69	0.58	1.22	0.96	2.41
F-test	**	NS	**	**	**	**	*
LSD <sub>0.05</sub>	2.61	2.06	1.99	1.69	3.54	2.78	6.99
CV%	5.7	2.7	18.9	10.2	7.7	11.9	13.4

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.

**Yield and yield attributes:** The combined analysis of variance showed a significant variation on days to curd initiation, curd height, curd diameter, biological yield, and economic yield and harvest index. Snow Best showed the longest days (47.75) to curd initiation while, Super White Top had the longest days (75.88) to curd maturity. Rami had the highest curd height (13.24 cm) while Super White Top had the highest curd diameter (18.17 cm). Similarly, Super White Top had the highest biological yield (51.67 mt/ha) and economic yield (27.41 mt/ha) whereas Snow Crown had the highest harvest index (58.14 %). The yield variation among the cultivars was influenced by the genetic characteristics and environmental factors and similar findings were reported by (Sharma et al., 2018; Giri et al., 2020; Shrestha, 2022). Similar variation was observed by (Giri et al., 2023; Rai & Kencho, 2024; Kindo & Singh, 2018; Shrestha, 2022). Highest yield performance by Super White Top was due to its consistence higher plant height, stem diameter, leaf length, leaf breath and net biomass accumulation. Higher biomass accumulation by the plant was always beneficial for yield performance since, the vegetative part had a major contribution on photosynthesis and carbohydrate synthesis (Basnet et al., 2023; 2017).

## Conclusion

The experiment revealed that the cultivar i.e., Super White Top and Snow Crown showed the consistent and prominent vegetative characteristics, and yield related characteristics (high biological yield, economic yield, and harvest index) as compared to other hybrid cultivars. Hence, Super White Top and Snow Crown could be promoted for cultivation in the agro climatic zones related to that of Tulsipur, Dang.

## DECLARATIONS

### Author contribution

Conceptualization, methodology: M.B., A.S., K.M., and K.C.D.; Software validation: M.B., and K.C.D.; Data curation: M.B.; Writing-original draft preparation: M.B.; Writing-review and editing: M.B., A.S., K.M., and K.C.D.; Supervision: M.B., and K.C.D. All authors have read and agreed to the published version of the manuscript.

**Conflict of interest:** The authors declare that they have no conflict of interest.

**Ethics approval:** This study did not involve any animal or human participant and thus ethical approval was not applicable.

**Consent for publication:** All co-authors gave their consent to publish this paper in AAES.

**Data availability:** The data that support the findings of this study are available on request from the corresponding author.

**Supplementary data:** Not available.

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