International Journal of Bioresource Science
Citation: IJBS: **11**(02): 145-151, December 2024
DOI: 10.30954/2347-9655.02.2024.8

RESEARCH PAPER

Application of Multiple Linear Regression for Predicting the Quality of Jasmine Flower Under Varying Packaging and Storage Conditions

Syed Mazar Ali[1*], Udaykumar Nidoni[2], Palanimuthu[3], Sharangouda Hiregoudar[2], Ramappa, K.T.[2], Ramesh, G.[4] and Nagraj Naik[5]

[1]Agriculture Research Station, Rajavanthi, Pavagada, Tumkur District, India
[2]Department of Processing and Food engineering, University of Agriculture Sciences, Raichur, Karnataka, India
[3]National Institute of Food Technology, Entrepreneurship and Management, Thanjavur, Tamil Nadu, India
[4]Department of Soil and Water Engineering, University of Agriculture Sciences, Raichur, Karnataka, India
[5]Pesticide Residue and Food Quality Analysis Laboratory, University of Agriculture Sciences, Raichur, Karnataka, India

*Corresponding author: majru12@gmail.com (**ORCID ID:** 0000-0002-1680-5941)

Received: 23-09-2024 **Revised:** 26-11-2024 **Accepted:** 06-12-2024

ABSTRACT

The present study investigates the effects of different packaging materials and storage durations on the quality of jasmine flowers stored at 5°C, focusing on key parameters such as browning index, moisture content, and freshness index. Four packaging materials P_0 (bamboo basket with newspaper lining), P_1 (corrugated fiberboard with PP lining), P_2 (corrugated fiberboard with PE lining), and P_3 (nylon bag) were evaluated over 16 days. Among these, P_2 demonstrated superior performance, recording the lowest browning index (47.89) and highest moisture content (47.6%) on the 16th day, effectively maintaining flower quality. Conversely, P_0 exhibited the highest browning index (54.04) and rapid moisture loss, leading to spoilage by the 12th day. Correlation analysis indicated a strong positive relationship between storage time and browning index (0.891), confirming that browning increases over time, while moisture content showed a negative correlation (-0.776) with storage duration. The multiple linear regression (MLR) model confirmed the significant influence of these components with higher determination of coefficient of R^2 = 0.98 which made them tool to predict quality determination in jasmine flower.

HIGHLIGHTS

- Determination of optimal packaging for Jasmine flowers.
- Predictive multiple regression model for quality determination.

Keywords: Flower shelf-life, Packaging material, Multiple linear regression

Jasmine (*Jasminumm ultiforum* L.) is a highly prized flower renowned for its delicate fragrance and aesthetic appeal. However, its short post-harvest shelf life poses significant challenges for the floriculture industry. Maintaining the quality of jasmine flowers during storage is crucial for ensuring their freshness, aroma, and overall marketability. Packaging materials and storage conditions play pivotal roles in preserving flower quality. Jasmine is an ideal crop for small farmers with less than one acre of land. The productivity of jasmine is affected by several constraints, including climate management (Sairam *et al*. 2022), irrigation

How to cite this article: Ali, S.M., Nidoni, U., Palanimuthu, Hiregoudar, S., Ramappa, K.T., Ramesh, G. and Naik, N. (2024). Application of Multiple Linear Regression for Predicting the Quality of Jasmine Flower Under Varying Packaging and Storage Conditions. *Int. J. Bioresource Sci.*, **11**(02): 145-151.

Source of Support: IUCEA; **Conflict of Interest:** None

water management (Santosh *et al*. 2023), and nutrient management (Maitra *et al*. 2024b). However, the market demand for jasmine flowers is seasonal, peaking during festivals and weddings, when prices are significantly higher (Nirmala and Champa, 2018). Jasmine plays an important role in India's economy, being a key crop for florists, landscaping, and the perfumery, cosmetic, medicinal, and pharmaceutical industries (Patel *et al*. 2017). India is a major center for the origin of many jasmine species, with 40 species identified, of which 20 are cultivated in South India (Safeena *et al*. 2017).

Post-harvest losses in flowers, due to their perishable nature, range from 7 to 13 percent (Thippaiah, 2005; Maitra *et al*. 2024a). These losses primarily occur during plucking, packing, and grading. While qualitative losses, such as reduced consumer acceptability of fresh flowers, are challenging to measure, quantitative losses can be traced throughout the market chain due to improper post-harvest handling (Bhattacharjee, 2006). In India, these losses may be higher due to limited knowledge of post-harvest handling techniques. The primary cause of such losses is poor infrastructure for post-harvest management (PHM) and inadequate processing facilities. Minimizing these losses requires proper handling, packaging, storage, marketing, and processing (Jain, 2016; Santosh *et al*. 2024). In light of these factors, the current study focuses on the effect of packaging materials and storage duration on the keeping quality of jasmine flowers.

The shelf-life stated on the product largely relies on commercial experience and conventional methods which are not consistent. Some predictive models developed for shelf-life evaluation are often expensive and laborious. Among these, electronic sensing for rapid diagnosis of food quality (Gómez*et al*. 2008) and a multiple linear regression model was reported to predict the shelf-life of roasted coffee, sterilized milk drinks (Goyal *et al*. 2012) or yogurt (Zhi *et al*. 2018 and Cruz *et al*. 2010). In recent years, we have witnessed the development and application of more reliable, effective and fast mathematical modelling, such as the weibull hazard model used for estimating the shelf-life of pezik pickles (Keklik *et al*. 2017). Fast mathematical modeling, such as the Q10 model (Dong *et al*. 2015), has been widely used for shelf-life evaluation of food products such as frozen shrimp.

Multiple linear regression (MLR) is another prediction tool which can help to forecast food deterioration and shelf life based on a number of factors. The model is prepared based on fitting a linear equation to observed data. The major advantage of this statistical method is its ability to show relationships between variables, although no causal mechanism is indicated. The multiple regression is easy to prepare and has been applied in food research to obtain models as an alternative to other statistical methods (Weiss *et al*. 2018).

MATERIALS AND METHODS

The experimental location, GKVK Bangalore, is located at 130 05" N latitude and 770 34" E longitude. The centre is at an altitude of 924 meters above mean sea level. The annual rainfall ranges from 528 mm to 1374.4 mm with the mean of 915.8 mm.

The jasmine flowers were harvested from the experimental plots of the University of Agricultural Sciences, Bangalore. Flowers are packed in CFB with Polypropylene (PP) lining; CFB with Polyethylene (PE) lining, bamboo baskets with newspaper lining; and nylon bags. Then they are stored specifically at a temperature of 5±2 °C for 16 days. Quality parameters of jasmine flower were assessed at an interval of 4 days during cold storage (5±2 °C).

The quality attributes of the flower including browning index, moisture content and freshness index of jasmine flower were observed in triplicate. Browning index of jasmine flower was calculated by formula reported by Heidari *et al.* (2023).

$$BI = \frac{100\,(X - 0.31)}{0.17} \qquad \ldots(1)$$

$$\text{Where, } X = \frac{a* + 1.75L*}{5{,}645L* + a* - 3.012b*}$$

Where,

L^*, a^* and b^* represents colour values

The moisture content (%) of flowers was determined using the procedure detailed by Simonyan *et al.* (2009). Fresh flower sample in quadruplicate were weighed in petri dishes and dried in an oven at

105 °C for 24 h (AOAC, 2005). The percentage loss in weight was expressed as percentage moisture content. The average moisture content was calculated using the following relationship.

$$\text{Moisture content (\% w.b.)} = \frac{W_1 - W_2}{W_1} \times 100 \quad \ldots(2)$$

The number of flowers which retained freshness without exhibiting petal wilting and browning were usually observed using the following score and expressed as per cent of fresh flowers or freshness index (Nirmala and Reddy, 1992).

$$FI = \frac{(7\times X1) + (6\times X2) + (5\times X3) + (4\times X4) + (3\times X5) + (2\times X6) + (1\times X7)}{(X1 + X2 + X3 + X4 + X5 + X6 + X7)\times 7} \times 100 \quad \ldots(3)$$

The score used for freshness index is illustrated as in Table 1.

Table 1: Freshness Index scores

Condition of flower	Score	Number of flower buds under respective score
Almost all buds turgid	7	X_1
Partial to half open flowers, turgid	6	X_2
Half to full open flowers, turgid	5	X_3
Partial to half open flowers, slightly wilted	4	X_4
Half to full open flowers, slightly wilted	3	X_5
Partial to half open flowers, fully wilted	2	X_6
Half to full open flowers fully wilted	1	X_7

The samples were evaluated for three replications and the result is expressed as a mean. Correlation between independent variables and dependent variables were defined for the observed data. To determine which quality influence the overall quality the Principal Component Analysis (PCA) was performed. Excel statistical software was used for analysis.

Multiple linear regression model was used in order to develop a model for overall quality changes during storage (Pripp, 2013). The general model of multiple linear regression uses the following equation;

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots\beta_k x_k + \varepsilon \quad \ldots(4)$$

where y is predictable variable value, β_0 is intercept, β_k is regression coefficient and ε is standard estimation error.

RESULTS AND DISCUSSION

The browning as well as the discoloration of loose flowers can damage their excellent appearance,thus leading to the decline of economic value. Effect of different packaging materials on browning index of jasmine flower at 5° C were observed and depicted in Table 2.

Table 2: Effect of packaging material on browning index (mg/g) in jasmine flower during storage period at 5°C

Packaging material	Browning Index (mg/g)			
	4th day	**8th day**	**12 days**	**16th day**
P_0	38.58	42.00	47.71	54.04
P_1	34.64	38.96	43.89	50.13
P_2	32.60	35.36	40.86	47.89
P_3	36.67	41.20	46.13	52.15
Mean	35.62	39.38	44.65	51.05
SEm(±)	0.75	0.79	0.80	0.77
CD@1%	2.51	2.62	2.67	2.58
CV. %	3.47	3.71	3.11	2.54
Significance	S	S	S	S

** Initial browning index = 27.23.*

P_0- Bamboo basket with Newspaper lining (Control); P_1- CFB with PP (100 gauge Polypropylene) lining; P_2- CFB with PE (100 gauge Polyethylene) lining; P_4- Nylon bag.h

Among the different packaging materials used browning index of jasmine flower was recorded minimum in P_2 (CFB with PE lining) for all the storage period. On 16th day of storage browning index of 47.89 was observed. In contrast, browning index of P_1(CFB with PP lining) P_0 (Bamboo basket with newspaper lining) and P_3 (Nylon bag) increases till 16th day and later on their shelf-life study was terminated due to spoilage. The control (P_0) showed a higher amount of browning index of 54.04 at the end of 16th day.

The discoloration causing browning process, which includes both enzymatic and non-enzymatic activities, has a major effect on the quality and shelf-life of fresh crops (Heidari and Rastegar. 2022). Results suggested by Umed, 2016 that delay in petal senescence by sucrose treatment is due to maintenance of sugar level in the petals, which delays a climacteric-like increase in ethylene production. Further this beneficial effect of GA_3 may have been enhanced by the effect of boric acid and packaging in CFB boxes. Refrigerated cut Flowers showed a slow rate of discolouration of petals, this was because low temperature inhibited ethylene biosynthesis and action. Ethylene has been shown to promote petal abscission and colour fading (Halevy *et al*. 1976).

The effective reduction in moisture content in jasmine flower indicates the advancement of senescence of flowers, thus it is an important factor that affects the shelf-life. Effect of different packaging materials on moisture content of flower at 5˚C were observed and depicted in Table 3.

Table 3: Effect of packaging material on moisture content in jasmine flower during storage period at 5 ºC

Packaging material	Moisture content (%)			
	4th day	**8th day**	**12th day**	**16th day**
P_0	72.51	65.49	50.46	40.21
P_1	79.01	75.37	65.29	47.60
P_2	81.17	78.08	67.73	51.10
P_3	73.40	67.48	52.05	42.18
Mean	76.52	71.60	58.88	45.27
SEm(±)	2.11	3.04	4.44	2.39
CD@1%	8.01	11.50	16.84	8.64
CV. %	2.16	2.11	3.22	1.65
Significance	S	S	S	S

- Indicates termination due to spoilage.

Initial Moisture content = 82.50%

P_0- Bamboo basket with Newspaper lining (Control); P_1- CFB with PP (100 gauge Polypropylene) lining; P_2- CFB with PE (100 gauge Polyethylene) lining; P_4- Nylon bag.

Among the different packaging materials used moisture content of jasmine flower was recorded maximum in P_2 (CFB with PE lining) for all the storage period. On 16th day of storage maximum moisture content of 47.60 % was observed in P_2 followed by P_1 (CFB with PP lining) with 51.10 %. In contrast, freshness index of P_0 (Bamboo basket with newspaper lining) and P_3 (Nylon bag) reduced drastically from 82.50% to 50.46 % at the end of 12th day and their shelf-life study was terminated due to spoilage. The control (P_0) showed a higher reduction in moisture content to 50.46% by the end of the 12th day.

Packaging of jasmine flowers with CFB box has maintained higher percentage of moisture content compared to other packing methods. Corrugated fiberboard boxes can help maintain a consistent level of humidity. This is particularly important during long-distance transportation, where flowers may be exposed to varying environmental conditions. The chemicals also retained the moisture content of flowers when used along with packaging. Packaging materials act as a barrier to prevent the exchange of moisture between the flowers and the external environment.

Effect of different packaging materials on freshness index at 5ºC were observed and depicted in Table 4.

Table 4: Effect of packaging material on Freshness Index (FI) in jasmine flower during storage period at 5 ºC

Packaging material	Freshness index °C			
	4th day	**8th day**	**12th day**	**16th day**
P_0	79.92	62.09	40.95	26.24
P_1	82.22	80.91	70.36	55.39
P_2	86.11	83.98	73.55	59.28
P_3	79.42	65.58	42.11	38.88
Mean	81.9	73.4	56.74	44.94
SEm(±)	0.73	0.89	0.57	0.08
CD@1%	2.47	3.0	1.91	0.27
CV. %	1.11	1.41	1.05	2.21
Significance	S	S	S	S

- Indicates termination due to spoilage.

Initial Freshness Index =100 P_0- Bamboo basket with Newspaper lining (Control); P_1- CFB with PP (100 gauge Polypropylene) lining; P_2- CFB with PE (100 gauge Polyethylene) lining; P_4- Nylon bag

Among the different packaging materials used freshness index of jasmine flower was recorded maximum in P_2 (CFB with PE lining) for all the storage period. On 16th day of storage maximum freshness index of 59.28 was observed in P_2 followed by P_1 (CFB with PP lining) which is 55.59. In contrast, freshness index of P_0 (Bamboo basket with newspaper lining) and P_3 (Nylon bag) reduced drastically from 100 to 26.24 at the end of 16th day and their shelf-life study was terminated due to spoilage. The control (P_0) showed a higher reduction in freshness index of 26.24 by the end of the 16thday.

Packaging jasmine flowers in CFB boxes has been found to maintain a higher percentage of fresh flowers compared to other packaging methods. The use of chemicals also helped retain the freshness of the flowers when combined with packaging. However, the effect of chemicals alone was less significant in maintaining freshness without proper packaging material. Packaging was crucial in maintaining optimal humidity levels, which slowed down the process of evapo-transpiration and ensured a proper balance of CO_2 and oxygen concentrations, thereby slowing down respiration. This observation is consistent with the findings reported by (Nirmala and Reddy, 1992). The results are in agreement with Nagaraja (1999) where treated tuberose flowers packed with 100 gauge polyethylene lining with no ventilation showed higher freshness index.

The correlation matrix shows the relationships between treatments, storage period (days), and browning index (Table 5).

Table 5: Correlation between the qualitative parameter analysed for browning index

Variable	Browning Index (mg/g)		
	Treatments	**Storage period (days)**	**Browning index**
Treatments	1.00	0.571	-0.633
Storage period (days)	0.571	1.00	0.891
Browning index	-0.633	0.891	1.00

The correlation coefficient (r) ranges between +1, 0 and -1. +1 indicates perfect positive correlation (as one variable increases, the other increases). Similarly -1 indicates perfect negative correlation (as one variable increases, the other decreases) and 0 indicates no correlation (no linear relationship between variables). The value 0.571 (Treatments vs Storage period) shows positive correlation. This indicates a moderate positive correlation between treatments and storage period. It means that certain treatments might be linked to specific storage conditions. For instance, a particular treatment may often be associated with longer storage periods. The value -0.633 (Treatments vs Browning index) shows a moderate negative correlation between treatments and the browning index. This suggests that the applied treatments reduce browning to some extent. Higher-quality treatments are associated with a lower browning index. Similarly, the value 0.891 (Storage period vs Browning index) indicates Strong positive correlation. A high positive correlation close to 1 indicates that as Storage period increases, the browning index also increases. This suggests that the longer the flowers are stored, the more browning occurs, which is a logical outcome given the nature of degradation over time.

The correlation matrix between Treatments, Storage period (days), and Moisture content is shown in Table 6.

Table 6: Correlation between the qualitative parameter analysed for Moisture content

Variable	Moisture content (%)		
	Treatments	**Storage period (days)**	**Moisture content**
Treatments	1.00	0.571	-0.598
Storage period (days)	0.571	1.00	-0.776
Moisture content	-0.598	-0.776	1.00

The value 0.571 (Treatments vs Storage period) shows positive correlation. This indicates a moderate positive correlation between treatments and Storage period. It means that certain treatment is linked to specific storage conditions. The value -0.598 (Treatments vs Moisture content) shows moderate negative correlation between treatments and the moisture content. This suggests that the applied treatments maintain moisture content to some extent. Higher-quality treatments are associated with a higher moisture content. Similarly the value -0.776 (Storage period vs Moisture content) shows Strong negative correlation. This value indicates that as Storage period increases, the moisture content decreases. This is expected, as flowers tend to lose moisture the longer they are stored, leading to drying out and quality deterioration over time.

The correlation matrix between Treatments, Storage period (days), and Freshness index is shown in Table 7. The value 0.571 (Treatments vs Storage period) shows positive correlation. This indicates a moderate positive correlation between treatments and Storage period. It means that certain treatments are linked to specific storage conditions. The value -0.472 (Treatments vs Freshness index) indicates that value is close to 0, indicating that the treatments used do not significantly affect the freshness of the flowers. This suggests that the chosen treatments have little impact on maintaining or changing flower freshness. The value -0.735 (Storage period vs Freshness index) shows moderate negative correlation between treatments and the freshness index. This suggests that the applied treatments maintain moisture content to some extent. Higher-quality treatments are associated with a higher freshness index.

Table 7: Correlation between the qualitative parameter analysed for Freshness index

Variable	Freshness index		
	Treatments	Storage period (days)	Freshness index
Treatments	1.00	0.571	-0.472
Storage period (days)	0.571	1.00	-0.735
Freshness index	-0.472	-0.735	1.00

Further in the next step, Principal component analysis (PCA) was performed using MS Excel. As a result of that new data set of components was obtained (Table 8). Principal component analysis is an approach used for identifying most crucial variable responsible for changes in industrialised food (Silva matians *et al.* 2016). The PCA precedes the usage of statistical methods and limits the number of factors analysed. The principal component values account for 85% of the total variance. PC loadings indicate how much each original variable (in this case, each day) contributes to a particular principal component (PC). A higher magnitude (positive or negative) means the corresponding variable has a greater influence on that principal component.

Interpretation of each Principal component shows, PC1 Captures the variance in browning across days. If most of the loading values are negative, it indicates a trend of increasing browning over time. PC2 captures the changes related to moisture content, possibly decreasing with time. Similarly, PC3 reflects the deterioration of freshness, which usually worsens with time. High negative values suggest a major decline in freshness.

Table 8: Principal component co-ordinates of the variables

Variable	PC1 (Browning index)	PC2 (Moisture content)	PC3 (Freshness index)
4^{th} DAY	-0.024	-0.264	-0.016
8^{th} DAY	-0.272	-0.348	-0.288
12^{th} DAY	-0.681	-0.543	-0.734
16^{th} DAY	-0.679	-0.619	-0.781

These loadings suggest that Storage period has a significant impact on all three-quality metrics (browning, moisture, and freshness), with browning and freshness being the most affected towards the later days (12^{th} and 16^{th} days).

In order to find out overall quality model of jasmine flower Eq.(4) and three principal component (PCs) selected for PCA analysis. The PCs are Browning index (PC1), moisture content (PC2) and freshness index (PC3). The coefficient of determination R^2 was found as 0.98.The MLR model was highly significant and specifically described the influence of storage conditions and components on the overall quality of jasmine flower. The MLR is shown below

$$Y = 30.9331 + 1.3104\, x_1 + 1.2583\, x_2 - 2.1325x_3 - 4.86x_4 \quad \ldots(5)$$

30.9331 is the intercept, which represents the predicted value of the Browning Index when all independent variables are 0.1.3104 is the coefficient for storage period (4 days), meaning that for each additional 4^{th} day. 1.2583, -2.1325, and -4.86 correspond to the coefficients for other independent variables (for packaging materials or different days).

CONCLUSION

This study highlights the significant impact of packaging materials and storage duration on the quality of jasmine flowers stored at 5°C. P_2 (corrugated fiberboard with PE lining) emerged as the most effective packaging, maintaining the lowest browning index and highest moisture content, thereby preserving flower quality for 16 days. In contrast, P_0 (bamboo basket with newspaper lining) resulted in rapid spoilage by the 12^{th} day due to high browning and moisture loss. The correlation analysis confirmed that browning increases with extended storage, while moisture content decreases over time. The Multiple Linear Regression (MLR) model, with an R^2 value of 0.98, accurately captured the influence of key quality parameters, establishing it as a reliable predictive tool for determining jasmine flower quality under varying storage conditions. Optimal packaging, particularly P_2, plays a crucial role in extending shelf life by minimizing browning and retaining moisture.

REFERENCES

Association of Official Analytical Chemists (AOAC), 2005. Official methods of analysis of the AOAC International.18th edition. Gaithersburg, MD, USA. pp. 45-48.

Bhattacharjee, S.K., 2006. Advances in ornamental horticulture. Pointer Publishers, Jaipur 302 003, Rajasthan, India. (6).

Cruz, A.G., Walter, E.H., Cadena, R.S., Faria, J.A., Bolini, H.M., Pinheiro, H.P. and Sant'Ana, A.S. 2010. Survival analysis methodology to predict the shelf-life of probiotic flavored yogurt. *Food Res. Int.*, **43**(5): 1444-1448.

Dong W.L., Xiao W., Li D.P. and Sun Z.H., 2015. Prediction of quality and storage period of soybean in small packages under different temperature. *Appl. Mech. Mater.*, **731**(1): 389–392.

Gómez, A.H., Wang, J. Hu, G. and Pereira, A.G., 2008. Monitoring storage shelf-life of tomato using electronic nose technique. *J. of Food Eng.*, **85**(4): 625–631.

Goyal, S. and Goyal, G.K., 2012. Shelf-life prediction of processed cheese using artificial intelligence ANN technique. *Croat. J. Food Technol. Biotechnol. Nutr.*, **7**: 184–187.

Halevy, A.H. 1976. Treatments to improve water balance of cut flowers, *ActaHorti.*, **64**: 274-283.

Heidari Krush, G. and Rastegar, S. 2023. γ-Aminobutyric acid (GABA) inhibits the enzymatic browning of cut Narcissus tazetta cv.'Shahla-e-Shiraz' flowers during vase life. *J. Plant Growth Regul.*, **42**(4): 2602-2612.

Heidari, A., Chegini, G., Kianmehr, M.H., Hassan-Beygi, S.R. and Khazaei, J., 2011. Influence of knife bevel angle, rate of loading and stalk section on some engineering parameters of lilium stalk. *Iran. J. Energy Environ.*, **3**(4): 333-340.

Heidari, A., Chegini, G., Kianmehr, M.H., Hassan-Beygi, S.R. and Azimi, S. 2014. Mechanical strength testing of rose flower stem and picking force evaluation. *Electron. J. Polish Agric. Univ.*, **14**(2): 4-10.

Jain and Ritu. 2016. Advances in packaging and storage of flowers. Commercial Horticulture, New India Publishing Agency, New Delhi, India, **1**(1): 473-88.

Keklik, N.M., Işikli, N.D. and Sur, E.B. 2017. Estimation of the shelf life of pezik pickles using Weibull hazard analysis. *Food Sci. Technol., Campinas*, **37**(Suppl. 1): 125–130.

Maitra, S., Sairam, M. and Santosh, D.T. 2024b. Evaluation of the growth, flower quality, yield and vase life of gerbera (*Gerbera jamesonii* L.) cultivars under open ventilated saw-tooth type polyhouse. *Res. on Crops*, **25**(1): 104-109.

Maitra, S., Sairam, M., Santosh, D., Gaikwad, D.J. and Sahoo, U. 2024a. Growth, productivity and quality of colored capsicum (*Capsicum annuum* L.) as influenced by hybrids and plant growth regulators under controlled environment conditions. *Res. on Crops*, **25**(2): 328-335.

Nagaraja, G.S., Gowda, J.V.N. and Farooqi, A.A. 1999. Shelf-life of tuberose f1owers as influenced by packaging and ventilation. *Karnataka J. Agric. Sci.*, **12**(1): 239-242.

Nirmala, K.S. and Champa, B.V. 2018.Diversity evaluation of floral morphological traits of *Jasminum* spp. in relation to flower trade.*Bull. Environ. Pharmacol. Life Sci.*, **7**(10): 75-81.

Nirmala, S. and Reddy, T.V. 1993. Shelf-life of jasmine (*Jasminum sambac*) flowers as influenced by packaging and ventilation. *Mysore J. Agric. Sci.*, **27**(3): 272–276.

Pripp, H. 2013. Application of multivariate analysis: benefits and pitfalls. *In:* Pripp H (ed) Statistics in food science and nutrition. Springer, Berlin, pp. 53–64.

Safeena, S.A.,Thangam, M., Priya, S., Devi and Singh, N.P., 2017. Genetic diversity of jasmine and its conservation under coastal humid ecosystem of Goa, *World J. Pharm. Life Sci.*, **3**(6): 116-123.

Sairam, M., Maitra, S., Shankar, T., Sagar, L. and Santosh, D.T. 2022. Performance of different gerbera (*Gerbera jamesonii* L.) cultivars under protected cultivation in south Odisha conditions. *Crop Res.*, **57**(3): 211-215.

Santosh, D.T., Maitra, S. and Tiwari, K.N. 2023. Optimizing nutrients through drip fertigation and plastic mulch on the growth and yield in banana (*Musa acuminata* L.). *Res. on Crops*, **24**(2): 330-336.

Santosh, D.T., Maitra, S. and Tiwari, K. 2024. Enhancing banana production through effective fertigation frequency management and plastic mulch: Impacts on crop growth and yield. *Res. on Crops*, **25**(1): 65-72.

Silva Matins, N., Ferreira, E.B., Piedade, S.M.S. and Lucia, F. D. 2016. Shelf-life prediction for non-accelerated studies (shenon) applied to minimally processed eggplant. *J. Food Nutr. Res.*, **4**(9): 592–595.

Thippaiah, P. 2005. Floriculture in Karnataka: Performance, problems and prospects. Research report: IX/ADRT/105, *ISEC*, Bangalore.

Weiss, D., Stangierski, J., Baranowska, H.M. and Rezler, R. 2018. Kinetic models of quality parameters of spreadable processed Gouda cheese during storage. *Food Sci. Biotechnol.*, **9**: 1–8.

Zhi, N.N., Zong, K, Thakur, K., Qu, J., Shi, J.J., Yang, J.L., Yao, J. and Wei, Z.J. 2018. Development of a dynamic prediction model for shelf-life evaluation of yogurt by using physicochemical, microbiological and sensory parameters. *CyTAJ. Food*, **16**(1): 42–49.