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Study on the Effect of Pre-harvest Fruit Bagging for Enhancing Fruit Quality in Mango cv. Baneshan

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Abstract

The experiment was conducted during March–June, 2021 to 2024 at Mango Research Station, Nuzvid, Dr. YSR Horticultural University, Andhra Pradesh, India to study the impact of bagging on fruit quality and pest and disease control. The experiment was laid out in RBD with 3 replications and 7 treatments of different coloured bags with and without transparent flip on bags. The fruits were bagged approximately at 100 g weight of the fruit uniformly in all treatments. Harvesting of the bagged fruits were done after 65 days of bagging along with bags and kept for ripening after removal of bags. After fully ripening of fruits the analysis was done for quality parameters. The results revealed that reddish brown bags were superior for average fruit weight (365.8 g), ascorbic acid (42.3 mg 100 g^{-1}), and total sugars (22.7%), followed by yellow and white bags. Thrips and sooty mould damage were recorded as minimum (8.67% 14.27, respectively) in reddish brown bags. Fruit fly damage was nil in bagged fruits, while the control recorded 42.33%. However, there was no significant difference observed between with flip and without flip within the same colour of bags for most of the quality parameters. Based on these results, pre-harvest bagging of fruits with reddish brown or yellow colour can be recommended to improve the fruit quality and to avoid pests and disease incidence, thereby reducing pesticide residues in mango to increase the exports.

Keywords: Pre-harvest bagging, fruit quality, pest and disease incidence

1. Introduction

Mango (*Mangifera indica* L.), the national fruit of India, is one of the most important tropical and subtropical fruit crops. It is popularly known as "King of Fruits" (Banyal et al., 2021) due to its delicious taste (Samy et al., 2023), excellent flavour, attractive colour (Srinivas and Sreedhar, 2017), huge variability, and varied end usage (Singh et al., 2013). It is rich in vitamins A and C (Rathore et al., 2007). Raw fruits are used for making chutney, pickles, raw mango dried flakes, and dried powder (amchur). The ripe fruits, besides being used for table purposes, are also utilized for preparing several value-added products like jam, jellies, squash, cordial, syrup, nectar, *etc.* (Rajendrakumar et al., 2001, Singh and Saxena, 2008; Jha et al., 2010). India is the leading country for mango production in the world, which occupies 23.93 mha with production of 22.84 mt (Anonymous, 2025). Andhra Pradesh and Uttar Pradesh states have the largest area under mango, each with around 25% of the total area, followed by Bihar, Karnataka, Kerala, and Tamil Nadu. In Andhra Pradesh, mango is grown in 1.39 lakh hectares and produces 49.86 lakh Metric tonnes (Anonymous, 2025). Baneshan (Banganpalli) is an important commercial variety grown in Andhra Pradesh, Telangana (Nissi Olive et al., 2025; Kaladhar Babu et al., 2015). It is one of the leading export varieties of India after Alphanso (Savan et al., 2024). India is the world's largest producer of mangoes, contributing approximately 41% of the global production Annonymous, 2023). Despite this, its share in global mango exports is only approximately 5–6% (Annonymous, 2023) indicating the huge gap in exporting of mangoes. This gap is mainly due to poor fruit quality in terms of appearance of fruit and also high pesticide residues. Fruit quality is certainly influenced by biotic and abiotic factors, and a main quality attribute is the external appearance of the fruit. In addition to changing climatic conditions, non-adoption of good agricultural practices leads to increased pest and disease incidence in mango. Hence, farmers are using pesticides indiscriminately to control these pests leads to increased production cost and pesticide residues on mango fruits, which is a major hurdle for mango exports. Further, some pests like the fruit fly cannot be controlled by insecticides alone. Bagging refers to the covering of fruits with bags to protect them from various biotic and abiotic factors (Veeramanikandan et al., 2024). Fruit bagging has emerged as a novel technology in practice, which is simple, grower-friendly, safe, and beneficial for the production of quality mangoes (Akhilesh et al., 2024; Sonam et al., 2023). It is a technique that provides physical protection to the fruits, which helps in improving their physical (Ramez et al., 2024) and internal quality (Md. Tariqul et al., 2019; Devalla et al., 2018) as well as changes the microclimate inside the bag for proper growth and development (Nagaharshithaet al., 2016).In mango, bagging also helps to prevent fruit fly attack (Sarkar et al., 2009; Karar et al., 2019) and fungal disease incidence (Hossain et al., 2020; Ravuri et al., 2024), which is a major concern for exports. Further, in recent years the climate change has spoiled the external appearance of fruit. Thus, bagging can be helpful under such conditions. Preharvest bagging possesses promise in the Baneshan mango, which has not been much attempted, and hence, the present study was conducted to study the effect of bagging on fruit qualityand pest and disease incidence in themango cv. Baneshan.

2. Materials and Methods

The experiment was conducted at Mango Research Station, Nuzvid, Dr. YSR Horticultural University, Andhra Pradesh, from March, 2021 to 2024. The experimental site was geographically situated at 16° 46' 48'' N latitude and 80° 50' 59''E longitude. The orchard soil type is red loamy soil. The experiment was laid out in a Randomized Block Design (RBD) with three replications consisting of 7 treatments. *viz.,* T_1: Reddish brown bag without flip, T_2: Reddish brown bag with transparent flip, T_3: Light brownbag without flip, T_4: Light brown with transparent flip, T_5: White bag without flip, T_6: white bag with transparent flip and T_7: Control (no bagging). Fifteen fruits were selected for bagging per replication per treatment. Bagging was done at 50 days after fruit set. The Baneshan variety of mango was selected for the study. The transparent flip with a polythene sheet was made on fruit covers before bagging of fruits in the respective treatments. The reddish brown and light brown bags are double-layered, while the white bag is single-layered. The bags were secured to the fruit stalk with the help of binding wire attached to the coveringin such a way that they will not fall down as well and there will not be open space for the entry of insects or rain. The data was recorded on the following parameters.

2.1. Fruit weight

Individual fruits were weighed using a digital electronic balance, and the average weight was mentioned in grams.

2.2. Total soluble solids (TSS)

The 'Erma' hand refractometer was used to measure the TSS in (°Brix).

2.3. Titrable acidity

10 ml of the homogenized sample was taken and made up to 100 ml volume with distilled water in a volumetric flask. The contents were filtered through Whatman No.1 filter paper. From the filtered solution, 10 ml was taken into a 250 ml conical flask and titrated with 0.1N NaOH by using phenolphthalein as an indicator until the aliquot turned into a light pink colour, which persisted for 15 seconds, was considered as an endpoint, and the titratable acidity was estimated in terms of % citric acid by using the following formula.

Acidity (%)=(Titre value×Normality of NaOH×equivalent weight of acid)/Weight volume of sample taken for estimation)×100
Equivalent weight of citric acid: 64.4 g

2.4. Ascorbic acid (mg 100 g^{-1})

Ten grams of mango pulp was blended with 3% metaphosphoric acid, and the volume was made up to 100 ml with metaphosphoric acid (3%). 10 ml of filtrate was taken into a conical flask and titrated with the standard 2,6-dichlorophenol-indophenol until a light pink colour was observed. The appearance of pink colour was taken as an endpoint when it persisted for 15 seconds. The ascorbic acid content was computed by using the following formula given by Ranganna (1986).

Ascorbic acid (mg 100 g^{-1})=(Titre value×dye factor×volume made up)/(Aliquot of extract×weight of sample taken for estimation)×100

Dyefactor= 0.5/Titre value

2.5. Total sugars (%)

The percentage of total sugars in the fruit was determined by Fehling's solution method, which was given by Rangana (1986). 10 g of pulp were taken, diluted with distilled water, and 2 ml of lead acetate solution for digesting the reducing sugars, and kept for 15 minutes. Later on, the solution was freed from lead by adding 2.1 ml of potassium oxalate crystals and filtering. An aliquot of 25 ml from the filtrate was taken into a conical flask to which 5 ml of 1% HCl was added, and the sample was left for inversion for 24 hours at room temperature. The final volume was made up to 250 ml and then titrated against boiling Fehling's solution using methylene blue as an indicator. The percentage of total sugar was expressed according to the following formula.

Total sugar(%)=(volume made up× 100) /(Titrate value×Weight of sample)×100

2.6. Reducing sugars (%)

10 g of fruit pulp was taken in a 250 ml volumetric flask, diluted with a small quantity of distilled water, and 2 ml of lead acetate was added to digest the reducing sugars and kept for 15 minutes.After completion of digestion, 2.1 ml of potassium oxalate is added to neutralize the excess lead, and the volume is made up to 250 ml with distilled water.

The solution is filtered and the filtrate is taken in a burette. Five millilitres of each Fehling's A and Fehling's B solutions were taken into a conical flask and diluted with 50 ml of distilled water. The solution is heated to boiling and titrated with the filtrate in a burette, while boiling discolouration of the Fehling's solution indicates the midpoint. Afew drops of methylene blue indicator were added, and the titration was continued until a bright brick red colour was obtained. This indicates the endpoint, and the reading is noted down as titre value for calculating the percentage of reducing sugars present in the sample by using the following formula.

Reducing sugar (%)=(factor for Fehiling's solution×Total volume made up)/(Titer×Weight of sample)×100

2.7. Non-reducing sugars (%)

The percentage of non-reducing sugars was calculated by subtracting reducing sugars from total sugars as reported by Ranganna (1986) using the following formula.

Non reducing sugars (%)=Total sugars (%)–Reducing sugars (%)

2.8. Shelf life of fruits

The shelf life in days was determined by observing the period from harvest until the fruit spoiled.

2.9. Percent damage by pest and disease

The % damage by pest and disease was recorded at the time of harvest and calculated with the following formula.

Pest or disease incidence percentage=(Number of infested/infected fruits/Total number of fruits)×100

The data obtained from the study werestatistically analysed according to the procedure given by Panse and Sukhatme (1985).

3. Results and Discussion

The results on fruit weight, quality parameters,and shelf life of fruits were presented in Table 1 and indicated that all bagging treatments improved fruit weight at harvest. Among the different types of fruit covers studied, T_1 (Reddish brown without flip) recorded the significantly highest average fruit weight (365.8 g), which was on par with T_2 (Reddish brown with flip) and T_4 (Yellow colour with flip), whereas T_7 (Control) recorded the minimum fruit weight (302.6 g). An increase in fruit weight with preharvest bagging could be attributed to the improvement in the microclimate around the fruit would have helped in the increase in fruit weight (Kire etal., 2016; Getheet al., 2021; Ravikanth et al., 2022). These results are also in line with the findings of Haldankar et al. (2015),Shinde et al. (2015) in mango.Total Soluble Sugars (TSS) were not influenced by the treatments. Similar results were reported by Ravikanth et al. (2022) for TSS in mango. The percentage of acidity was found significantly highest (0.248%) in T_1, and it was comparable with T_7 (Control), while Acidity was low (0.149%) in T_4 (Yellow colour with flip). All the treatments except T_4 (Yellow colour with flip) and T_7 (control) have recorded significantly the highest ascorbic acid content. However, T_6 (white colour with flip) recorded thehighest ascorbic content (43.77 mg 100 g^{-1}), which was followed by T_1 (reddish brown without flip) and T_5 (white colour without flip). Preharvest bagging improved the ascorbic acid content was also reported by Malshe and Parulekar (2017) in the mango cv. Alphanso. For reducing sugars, T_5 (white colour without flip) recorded the highest percentage (5.8%), which was on par with T_4 (Yellow with flip). However, there was no significant difference observed for non-reducing sugars. Total sugars were significantly highest (22.7%) in T_1 (Redish brown without flip). The bagging of fruits improved the sugar content in the fruits. The variation observed in the chemical composition of mango fruits could be attributed to the changed microenvironment around the fruit during its growth and development. The results are in accordance with Hong et al. (2009); Ding and Syakirah (2010); Nagaharshitha et al. (2014), and Haldankar et al. (2015). None of the treatments showed significant results for the shelf life of the fruit in the present study.

Table 1: Effect of different fruit covers on quality parameters of mango cv Baneshan

Treatments	Fruit weight (g)	TSS (%)	Acidity (%)	Ascorbic acid (mg 100 g^{-1})	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Shelf life (days)
T_1	365.8	17.5	0.24	42.3	4.9	17.8	22.7	7.1
T_2	357.7	18.1	0.17	36.2	4.9	15.0	19.9	6.9
T_3	323.9	17.4	0.16	35.8	4.5	13.4	17.9	6.3
T_4	334.0	17.3	0.15	33.6	5.3	14.8	20.1	6.1
T_5	325.2	17.4	0.22	41.3	5.8	13.9	19.7	6.8
T_6	321.9	17.8	0.19	43.8	4.7	14.4	19.1	6.2
T_7	302.6	16.7	0.25	28.9	5.5	14.0	19.5	5.2
CD (p<0.05)	35.4	NS	0.06	9.5	0.7	NS	2.5	NS
SEm±	11.8	0.5	0.02	3.1	0.2	1.1	0.8	0.4
CV%	7.1	5.8	17.6	14.2	8.2	12.6	7.2	10.7

Fruit bagging significantly reduced the major pests and diseases that occur during the fruit development stage (Table 2). The percent damage by thrips wasrecordedas minimum (8.67%) in fruits covered with reddish brown colour covers (T_1 and T_2), which was followed by yellow colour covers (T_3 and T_4) and white colour covers (T_5 and T_6). About 30.8% to 74.71% damage reduction was found in bagging treatments over control (No bagging) in case of thrips. Fruit fly damage was not found in bagged fruits, while in the control, the damage by fruit fly was 42.33%. (Table 2) and it clearly indicates that fruit bagging showed 100% protection against control.Sarker et al. (2009) also reported that fruit fly incidence was not observed in bagged fruits.Sooty mould disease % damage incidence (PDI)was significantly lower (12.34%) in T_3, and this was on par with T_1 (14.27%). However, when compared to the control, both thrips and sooty mould damage were foundto be lowest in all bagged fruits. These results clearly showed that fruitbags acted as a physical barrier for pests and diseases, and hence, low pest incidence was recorded. Egg laying by the fruit fly was completely restricted by fruit bagging, and hence its damage was not recorded in bagged fruits when compared to non-bagged fruits. Tejasree et al. (2022) and Ravuri etal. (2024) also reported that fruits bagged with a brown paper bag do not record insect pests like thrips, fruit fly, and fruit borer in the mango cv. Neelum. Ali et al. (2021) stated that by altering the microenvironment of the fruit, bagging facilitates a reduction in pest infestation, sunburn, and blemishes, etc.

Table 2: Effect of different types of covers on pest and disease incidence in mango

Treatments	Thrips (% damage)	Damage reduction over control	Fruit fly (% damage)	Damage reduction over control	Sooty mould (PDI)	Damage reduction over control
T_1	8.67 (17.09)	74.7%	0	100%	14.27 (22.17)	57.0%
T_2	15.75 (23.37)	54.1%	0	100%	15.96 (23.54)	51.9%
T_3	21.17 (27.36)	38.3%	0	100%	12.34 (20.55)	62.8%
T_4	18.96 (25.79)	44.7%	0	100%	15.76 (23.38)	52.5%
T_5	22.41 (28.24)	34.6%	0	100%	16.53 (23.97)	50.2%
T_6	23.74 (29.16)	30.8%	0	100%	18.62 (25.54)	43.9%
T_7	34.29 (35.79)		42.33 (40.59)		33.21 (35.10)	
CD (p<0.05)	1.97		0.98		3.11	
SEm±	0.63		0.10		0.99	
CV%	4.10		9.51		6.94	

Figures in parentheses are the transformed arch sign values

4. Conclusion

Pre-harvest fruit bagging improved the fruit quality, reduced pests and disease incidence, hence reduced pesticide usage, thereby reducing pesticide residues on the fruit of mango. Mango yield was also increased due to increased fruit weight.

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