

Effect of Coloured Polythene Bags on Fruit Quality of 'Himsagar' Mango Grown in New Alluvial Zone of West Bengal

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Authors' contributions

This work was carried out in collaboration among all authors. Author SD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SS and PD managed the analyses of the study. Author SS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The study was aimed to investigate the effect coloured polythene bags on fruit quality of 'Himsagar' mango grown in New Alluvial Zone of West Bengal, India.

Methodology: Field experiment was conducted at Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, India (22°56" N, 88°31" E and 9.75 m above mean sea level) during the period from 2017 to 2018. The experiment was laid out in completely randomized block design (RBD) having six distinct bagging treatments (T₁- Blue polythene bag, T₂- Green polythene bag, T₃- Yellow polythene bag, T₄-Red polythene bag, T₅- White polythene bag, and one control i.e. T₆- No bag), replicated four times. Fruit physical parameters, bio-chemical parameters, physiological loss in weight and disease incidence % at different days of storage were analyzed in this experiment.

Results: Experimental findings showed that among different colour of bags, green colour (T₂) proved most effective as most physical parameters and bio-chemical constituents of fruit were

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improved in this treatment. Fruits at 8 days storage at ambient room temperature showed maximum total soluble solids, total sugar and β -carotene content with the application of green colour bag. This treatment also exhibited less physiological loss in weight (PLW) with minimum incidences of post harvest diseases during storage at ambient room temperature.

Conclusion: Findings from this study show that fruit bagging with green polythene bag proved most effective in increasing the fruit weight and bio-chemical constituents of mango with less incidence of diseases that ultimately leading to better consumer acceptance and gives higher return to the growers.

Keywords: Mango; Himsagar; bagging; fruit weight; β -carotene content; physiological loss in weight.

1. INTRODUCTION

Mango (*Mangifera indica* L.) grows throughout the tropical and subtropical parts in the world for its wide adaptability [1]. It is considered one of the choicest fruit for its attractive colour, delicious taste and immense nutritional value [2]. India is the leading producer of mango in the world with approx 40% share. Mango production alone contributes one fifth of total fruit production in India [3]. The production of Mango cv. Himsagar in West Bengal has been increasing rapidly in the last few years for its huge demand within and beyond the state. The cultivar Himsagar also got GI tag from West Bengal for its unique flavour creates huge export options. For production of export quality Himsagar mango prime requirement is to produce spotless unblemished fruits. Recent climate changes such as abnormal rainfall, sudden fluctuations in the temperature, fog, etc. especially during fruit development period adversely affect mango fruit by causing physical damage or by aggravating the pest and diseases such as fruit borer, anthracnose, stem end rot etc [4]. Bagging may be useful as a means of preventing such problems in mango and can reduce disease and physical damage thereby developing attractive colour & good fruit size [5,6]. Different bagging materials behave in different ways [7]. Most of bagging materials could protect gases and humidity exchange in some levels. Researchers over the world reported success of use of various packaging materials viz. black polythene, white polythene, tissue paper, brown paper, newspaper etc. in different fruits like guava, apple, banana, mango etc [8]. Though few experiments have been carried out with principal aim to study the effect of different bagging materials on fruit maturity, quality and disease pest infestation on mango and very useful outcome obtained in recent past, but till information regarding impact of different colour bagging on fruit quality and ripening of mango especially on cultivar 'Himsagar' is lacking. Keeping these facts in mind, the present

investigation was undertaken to examine the effect of colour bags on fruit quality of mango.

2. MATERIALS AND METHODS

2.1 Experimental Site and Treatment Details

The experiment was carried out at Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, India (22°56" N, 88°31" E and 9.75 m above mean sea level) during the period from 2017 to 2018. The selected 'Himsagar' trees were healthy, uniform in size and about 13 years old. The experiment was laid out in completely randomized block design (RBD) having six distinct bagging treatments (T₁- Blue polythene bag, T₂- Green polythene bag, T₃- Yellow polythene bag, T₄-Red polythene bag, T₅- White polythene bag, and one control i.e. T₆- No bag), replicated four times. Eighty numbers of fruits were subjected to each bagging treatment. So total four hundred eighty (480) number fruits of 10 selected Himsagar trees were tagged which finally used for bagging. Tagged developing mangoes were bagged with different coloured polythene bags with two lower slit about 0.5 cm diameter and of about 0.8 to 0.9 mm in thickness at 40 days after fruit set. In control treatment 80 fruits were left as such in the tree without bagging. While bagging the plastic bags were stapled properly, so that it will not fall down as well as there will not be open space for entry of insects or rain etc. The bags were pinned holed (few) with small pins for aeration and gaseous exchange.

2.2 Observations Recorded

2.2.1 Fruit physical parameters

Fruit physical parameter such as fruit length, breadth determined with the help of digital slide calipers (6"/150 mm, accuracy ± 0.02 mm, LR44,

2006/66/EC) and weight, pulp weight, stone weight measured using digital weighing balance.

2.2.2 Fruit bio-chemical parameters

As quality part, bio chemical properties of fruits assessed at 4 and 8 days of ambient storage (temperature and RH of storage room recorded in between 24-27°C and 65-70%, respectively). The total soluble solids (TSS) was estimated using digital refractometer (ATAGO, RX 5000, Tokyo, Japan) and was expressed as °Brix. Titratable acidity was determined by titrating 5 mL of juice against 0.1 N NaOH and expressed as % [9]. Total sugar (%), reducing sugar (%) and non-reducing sugar (%) were determined as per the guidelines of AOAC [10].

2.2.3 Physiological Loss in Weight (PLW) and disease incidence%

Physiological loss in weight (PLW) was calculated as cumulative % loss in weight based on the initial fruit weight (before storage) and loss of weights recorded at the time of periodical sampling during storage [11]. Disease affected fruits mainly anthracnose and stem end rot (most prevalent postharvest diseases) were determined and confirmed by their characteristic visual symptom. The disease incidence % of the treated fruit was worked out using following formula:

$$\text{The percentage of disease} = \frac{\text{[No. of diseased fruits]} \div \text{Total no. of fruits}}{\times 100}$$

2.3 Statistical Analysis

The statistical analysis was performed following the analysis of variance (ANOVA) for randomized block design based on the guidelines given by Panse and Sukhatme [12]. The "P" value of data was estimated by students paired t-test.

3. RESULTS

3.1 Fruit Physical Attributes

Data presented in Table 1 revealed that different colour of bags significantly improved the fruit physical parameters. Maximum weight (260.00 g) of fruit was obtained from green colour bag (T₂) followed by 246.00 g in yellow colour bag (T₃) while control (T₆) fruit recorded minimum weight (238.00 g). Fruit length and fruit breadth were also affected due to fruit bagging with different colours. Maximum length of fruit (8.19 cm) and breadth (7.31 cm) were recorded from fruit

bagging with green colour (T₂) while control (T₆) fruit recorded minimum length (7.93 cm) and breadth (6.93 cm) of fruit. Table 1 also indicated that treatment of bagging with different colour bag significantly increased the pulp and stone weight of mango fruit. Maximum weight (183.00 g) of pulp was measured from bagging with green colour bag (T₂) followed by T₄ i.e. in red colour bag (173.00 g) while minimum (167.36 g) was recorded from unbagged fruit (T₆). Maximum weight of stone (27.01 g) was obtained from green coloured bag (T₂) while minimum (21.72 g) was obtained from control fruit (T₆).

3.2 Fruit Bio-chemical Attributes at 4 Days of Storage

It is evident from the data presented in Table 2 that total soluble solids content of fruit at 4 days of storage at room temperature was influenced significantly by different colour of bags. Fruit with white colour bag (T₅) showed maximum (17.62°Brix) total soluble solids followed by fruit with no bag (T₆) while minimum (15.10°Brix) was observed in fruits with green colour bag (T₂). Like total soluble solids, total sugar content of fruit was also influenced by different treatments of bagging. Maximum total sugar content (13.09%) of fruit was recorded in white colour bag (T₅) followed by control (T₆) fruit while minimum (11.04%) recorded in green colour bag (T₂). Maximum reducing sugar (3.92%) and non-reducing sugar (9.47%) content of fruit were obtained from white colour bag (T₅) and control (T₆) fruits respectively while fruits bagged with green colour (T₂) showed minimum reducing sugar (2.99%) and non-reducing sugar (8.10%), respectively. Titratable acid content of fruit was significantly increased due to different treatments of fruit bagging. Control fruit (T₆) recorded minimum titratable acid content (0.15%) of fruit while fruits with red bag (T₄) recorded maximum acid content (0.20%) of fruit. Experimental findings also revealed that β-carotene content of fruit varied significantly due to different bagging treatment at 4 days of storage. Maximum β-carotene (7026.67 µg/100 g fruit) was recorded in un-bagged fruit (T₆) while minimum (6316.67 µg/100 g) was measured in fruits bagged with green colour (T₂) in 4 days of storage at ambient room temperature.

3.3 Fruit Bio-chemical Attributes at 8 Days of Storage

It is revealed from the data presented in Table 3 that the total soluble solids content of fruit

significantly varied due to different treatments of bagging and there was an increased percentage of TSS content from un-bagged upon coloured bagging. Maximum TSS content (19.20°Brix) of fruit at 8 days of storage at ambient room temperature was recorded in fruits with green colour bag (T_2) followed by 18.04°Brix in fruits bagged with blue colour (T_1) bag while fruits in no bag (T_6) recorded minimum (14.09°Brix) value. Total sugar content of fruit at 8 days of storage at ambient room temperature varied from 9.10% to 15.21% due to different treatment of bagging. Fruits bagged with green colour (T_2) showed maximum total sugar content (15.21%) followed by 14.04% in blue colour bag (T_1) while control (T_6) fruit recorded minimum total sugar (9.10%). Reducing and non-reducing sugar content of fruit at 8 days of storage showed significant differences due to different bagging treatments. Fruits bagged with green colour (T_2) showed maximum reducing sugar (3.86%) and non-reducing sugar (11.34%) content of fruit while control fruit (T_6) recorded minimum reducing sugar (3.00%) and non-reducing sugar (6.10%). Titratable acid content of fruit at 8 days of storage showed significant difference among the different colour of bags. Fruit bagged with green colour (T_2) showed minimum titratable acid content (0.12%) while fruit bagged with white

colour (T_5) showed maximum titratable acid content (0.16%). Results revealed that, β -carotene content of fruit varied due to different treatment of bagging. Fruit bagged with green colour (T_2) showed maximum β -carotene (7157.78 $\mu\text{g}/100\text{ g}$) followed by T_1 i.e. in blue colour bag (6941.11 $\mu\text{g}/100\text{ g}$) while minimum (5936.30 $\mu\text{g}/100\text{ g}$) was noted from control (T_6) fruit.

3.4 Physiological Loss in Weight

Data presented in Table 4 indicated that physiological loss in weight (PLW) at 4 days of storage was higher in control fruit while lower PLW was observed in fruit bagged with different colour bags. Among different colour of bags, fruit bagged with green colour (T_2) showed minimum weight loss (11.26%) followed by 12.19% in yellow bag (T_3) while maximum (14.81%) was noted in control fruit (T_6). Similar observation was also noted in ripening of fruits at 8 days of storage where minimum weight loss (20.70%) was measured in fruit bagged with green colour (T_2) followed by 20.90% in yellow bag (T_3) and control fruit (T_6) recorded maximum weight loss (26.19%).

Table 1. Effect of bagging on physical characters of mango cv. Himsagar at harvest

Treatments	Fruit physical characters				
	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Pulp weight (g)	Stone weight (g)
T_1 -Blue bag	241.00	8.12	7.10	170.67	26.84
T_2 -Green bag	260.00	8.19	7.31	183.00	27.01
T_3 -Yellow bag	246.00	8.00	7.00	172.12	26.06
T_4 -Red bag	245.00	8.02	7.02	173.00	25.40
T_5 -White bag	240.00	8.06	6.96	169.90	24.23
T_6 -No bag (Control)	238.00	7.93	6.93	167.36	21.72
SEm \pm	0.78	0.03	0.02	0.59	0.31
CD ($p \leq 0.05$)	2.48	0.10	0.08	1.87	0.99

Table 2. Effect of colour bags on bio-chemical composition of ripe fruits at 4 days of storage

Treatments	TSS (°Brix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Titratable acidity (%)	β -carotene ($\mu\text{g}/100\text{ g}$)
T_1 -Blue bag	15.16	11.53	3.04	8.53	0.17	6621.48
T_2 -Green bag	15.10	11.04	2.99	8.10	0.19	6316.67
T_3 -Yellow bag	15.80	11.90	3.11	8.66	0.18	6400.00
T_4 -Red bag	16.24	12.03	3.69	8.30	0.20	6496.67
T_5 -White bag	17.62	13.09	3.92	9.04	0.17	6683.33
T_6 -No bag (Control)	16.88	12.53	3.15	9.47	0.15	7026.67
SEm \pm	0.10	0.06	0.05	0.05	0.007	36.61
CD ($p \leq 0.05$)	0.32	0.20	0.17	0.17	0.023	116.84

Table 3. Effect of colour bags on bio-chemical composition of ripe fruits at 8 days of storage

Treatments	Fruit bio-chemical characters					
	TSS (°Brix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Titratable acidity(%)	β-carotene (µg/100g)
T ₁ -Blue bag	18.04	14.04	3.70	10.19	0.14	6941.11
T ₂ -Green bag	19.20	15.21	3.86	11.34	0.12	7157.78
T ₃ -Yellow bag	17.75	13.82	3.41	10.49	0.14	6907.78
T ₄ -Red bag	17.32	13.37	3.68	10.01	0.13	6664.07
T ₅ -White bag	17.72	13.86	3.10	10.65	0.16	5987.78
T ₆ -No bag (Control)	14.09	9.10	3.00	6.10	0.14	5936.30
SEm±	0.04	0.03	0.02	0.02	0.002	33.56
CD ($p \leq 0.05$)	0.13	0.10	0.07	0.05	0.008	107.11

Table 4. Effect of colour bags on PLW (Physiological Loss in Weight) and disease incidence % (Anthracnose and Stem-end-rot) of mango cv. Himsagar at 4 and 8 days of storage

Treatments	PLW (Physiological loss in weight) %		Anthracnose %		Stem-end-rot %	
	4 days of storage	8 days of storage	4 days of storage	8 days of storage	4 days of storage	8 days of storage
	T ₁ -Blue bag	12.80	22.03	0.00	8.67	0.00
T ₂ -Green bag	11.26	20.70	0.00	5.00	0.00	6.33
T ₃ -Yellow bag	12.19	20.90	0.00	9.67	0.00	8.33
T ₄ -Red bag	12.65	21.75	0.00	9.67	0.00	8.33
T ₅ -White bag	13.60	23.36	0.00	50.00	0.00	44.00
T ₆ -No bag (Control)	14.81	26.19	4.67	61.67	10.00	70.67
SEm±	0.05	0.09	0.14	0.39	0.24	0.82
CD ($p \leq 0.05$)	0.15	0.27	0.43	1.24	0.75	2.61

3.5 Disease Incidence

Pre-harvest bagging with different coloured bags significantly reduced the post harvest diseases of fruits like anthracnose and stem-end-rot. Fruits at 4 days of storage showed minimum disease incidence while it was increased in 8 days of storage. Fruit bagged with any of the coloured bags had a significantly lower incidence of disease. Fruit bagged with green colour (T₂) showed minimum (5.00% and 6.33%) incidence of both the diseases followed by T₁ i.e. in blue colour bag (8.67% and 6.33%) while higher incidence was noted in T₆ i.e. in control fruits (61.67% and 70.67%) and T₅ i.e. in white colour bag (50% and 44.00%) as shown in Table 4.

4. DISCUSSION

The result of present investigation clearly demonstrated the benefits of different coloured polythene bagging for development of mango fruits and improvement in fruit quality. The fruit bagging has increased the individual fruit weight and size of the fruits. Similar observations were also noted by Tyas, et al. [13] in litchi, Johns and

Scottz [14] in banana and Ahmed [15] in mango. Among the different colour of bag, green colour bag (T₂) proved most effective in increasing fruit weight and size. This is may be due to differences in the light reflectance, absorbance and for transmission patterns in the visible, far-red, and/or infra-red regions of the spectrum as mentioned by Sharma, et al. [16]. Research findings reveals that the increasing of temperature by 0.5°C for exercising bagging in fruit crops increased the rate of fruit development which results in production of fruit having approximately 10-16% greater size and weight [17]. Bagging also improved the fruit size through other effects such as increased relative humidity and therefore reduced fruit water loss [18]. Bio-chemical constituents of fruits at 4 days of storage were varied for utilisation of differential colour bagging matter. Control fruit or fruit bagged with white colour polythene bag recorded maximum quantities of these constituents while fruit bagged with other colour showed minimum or less quantities except titratable acid content. This is might be due to fact that polythene bagging delayed the development of ripening characteristics of fruit which probably for

maintenance of improved temperature regime inside the bags. In bagged fruits usually day/night temperature fluctuations were reduced and there was a cut off in the temperature curve inside the bag, which considerably reduced the periods [19]. Similar observation was also noted by Ahmed [15] in mango. Poly-bagged fruits at 8 days of storage showed increased quantities of total soluble solids, total sugar and β -carotene content as compared to control fruits; this might be due to less infection of diseases and reduced weight loss. Similar result was obtained by Dutta and Majumder [20] in Himsagar mango. Pre-harvest bagging with different coloured bags significantly reduced the post harvest diseases of mango. Fruit bagged with any of the coloured bags had a significantly lower incidence of diseases. Green coloured bag (T_2) proved most effective than the other colour. This is might be due to development of better microclimate inside the coloured bag which protects the fruit from any chance of direct or vector (insect-pest) mediated disease inoculation. Besides, pre-harvest fruit bagging is an effective technique to provide physical separation between the environment and the fruit, which helps to protect against pathogens [16].

5. CONCLUSION

Thus, finally it is prescribed that fruit bagging with green polythene bag (T_2) may be practiced by the farmer as it is effective in increasing the fruit weight and bio-chemical constituents of mango fruit with minimum incidence of diseases that ultimately leading to better consumer acceptance and gives higher return to the growers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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