



Influence of Fruit Bagging on Chemical Quality of Mango (*Mangifera indica* L.) Varieties

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Authors' contributions

This work was carried out as Masters Research work of first author. Author NIS was guide and helped in critical stages of the research period as data analysis and thesis writing. Authors RKS and PDS helped in research work as manage literature, improving language and statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to study the Influence of fruit bagging on quality of mango fruit (*Mangifera indica* L.) in different varieties viz., Kesar, Alphonso, Langra, Vanraj. The treatments comprised with five different colures of bags (brown, old newspaper, yellow, and white) with control. Organoleptic evaluation (colour (7.33) and taste (7.47)) and carotenoides content (4.07 µg/g of tissue) recorded significantly maximum in brown paper bags (T₁). Significantly maximum carotenoids content (5.60 µg/g of tissue) recorded in interaction between brown paper bagged Kesar fruits (V₁T₁) and higher content of chlorophyll was in unbagged Vanraj fruits (V₄T₅). It is concluded from the present study that the under South Gujarat condition, Fruits were bagging with brown paper bag, gave better results in all of the parameters. Kesar and Alphonso variety showed better results in respect of the parameters. Kesar variety (V₁) recorded maximum organoleptic

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evaluation colour (7.42), texture (7.63), taste (7.55), flavor (7.50)], TSS (20.58 °B) and carotenoids contents (3.90 µg/g of tissue), whereas, Alphonso variety (V₂) recorded highest quantity of total sugar (14.15%), reducing sugar (4.04%), non-reducing sugar (10.11%) and ascorbic acid (22.23 mg/100 g pulp). The minimum titrable acidity (0.16%) was obtained with both Langra and Vanraj varieties. Vanraj variety (V₄) received maximum chlorophyll content (4.48 µg/g tissue).

Keywords: *Mango; bagging; quality; Gujarat.*

1. INTRODUCTION

Mango (*Mangifera indica* L.) Belongs to the family Anarcardiaceae and it is the most important fruit of Asia. Due to its excellent flavor, delicious taste, delicate fragrance and attractive colour, it is known as 'King of fruits'. It is a national fruit of India and occupies a unique place among the fruit crops grown in India. All parts of the mango tree *i.e.*, inflorescence, fruits, leaves, twigs, bark and wood are used because of its various nutritive and medicinal properties and also for religious purpose. The important mango cultivars such as Alphonso, Kesar, Rajapuri, Dashehari are early while Neelum, Malgoa, Karanjio, Amrapali, Totapuri, Langra, Sardar and Vashi Badami are under late maturing varieties. However, new hybrids cultivars viz., Ratna, Sindu, Neelphonso, Neeleshan, Neeleshwari, Sonpari are also popular and accepted by orchardist in South Gujarat for commercial cultivation. Among these, Kesar and Alphonso are leading varieties of Gujarat with medium fruit size, good shape, excellent fruit and keeping quality. They are one of the choicest varieties of the country and mostly preferred cultivars for commercial cultivation due to demand in domestic and export markets. It has been found good for canning purpose also. Langra variety is original to Varanasi area of Uttar Pradesh. It is extensively grown in northern India. Fruit is of medium size, ovate shape and lettuce green colour. Fruit quality is good. Keeping quality is medium. It is a mid season variety. Vanraj is a highly prized variety of Vadodra district of Gujarat and fetches good returns. Fruit is medium in size, ovate oblong in shape and colour is deep chrome with a blush of jasper red on the shoulders. Fruit quality and keeping quality are good. Mango fruit is highly perishable in nature and prone to various biotic and abiotic infections during the fruit growth and developmental stage [1]. Various approaches has been suggested by researchers (proper harvesting, pre-cooling treatments, waxing of fruits) to increasing the shelf life and enhance quality of mango fruits only after harvest [2]. These practices are might be useful up to some extent. But at the same time pre-harvest

management of fruit is equality important to insure the quality and health of fruit. Bagging of fruit is a one of the best pre-harvest practices followed by the farmers to protect the fruit damages and getting qualitative fruits from the tree [3] and [4]. Bagging is the covering of individual fruit with specially designed paper or cloth bags which protects fruits from pests, fungal infections, and diseases, mechanical damage, reduces spraying of insecticides, and provides an estimate of harvestable fruits per tree. It also helps in protecting the fruit from mechanical and physical damage (bruises, wounds, scars) occurring due to diseases and pest attack [5]. Earlier various researchers has reported the effect of different bagging materials (Newspaper bag, Brown paper bag, Scurling bag, Polythene bag, Butter paper bag, Muslin cloth bag, and Brown paper bag with polythene coating on quality of mango fruits *i.e.* [6,7,8] and [9], they found all bagging materials gave 100% protection of mango fruits against the fruit fly infestation, bagging of fruits with brown paper bag was found to be the best in protecting mango fruits and provides almost similar total soluble solid (TSS °Brix) and physical fruit quality in bagged fruits when compared with the un-bagged healthy fruits of the control treatment [8]. So keeping in mind the previous findings on types of bagging materials, the colure of bagging material could be the quality influencing factors for fruits. With this view, the present investigation was carried out to find "Influence of different colors of paper bags on quality of mango varieties.

2. MATERIALS AND METHODS

The experiment was conducted in the month of March 2011 to June 2011 at the Agriculture Experimental Station (AES), Paria, which is situated in Valsad district of Gujarat at an elevation of 10 meters above mean sea level latitude of 20°-57' N and east 72°-54' E longitude. The Paria fruit research station represents tropical climate characterized by fairly hot and humid summer, warm monsoon with more humidity and moderately cold winter. The rainfall in this zone is heavy and normally received from

southwest monsoon commences from second week of June up to end of September. Temperature ranges in rainy season is 20° to 30°C. The experiments was laid out in a Randomized Block Design with Factorial arrangement (RBD) with twenty treatment combinations comprising five bagging materials and four varieties same ages of mango trees. All treatments were replicated four times and 80 fruits were taken per treatment per replication. So there was total 400 fruits were investigated per variety of mangoes (320 fruits for different paper bags and 80 fruits for control). Treatment details are as follows: T₁- Brown colour paper bag, T₂- Old newspaper bag, T₃- Yellow colour paper bag, T₄- Yellow colour paper bag and T₅- Control with varieties viz., V₁- Kesar, V₂- Alphonso, V₃- Langra and V₄- Vanraj. Egg sized fruits were selected for bagging. In case of more than two fruits in a cluster, the smaller underdeveloped, deformed fruits, spotted fruits were removed by secator and only 1-2 healthy fruits were bagged. While bagging the different paper 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. Observations of chemical parameters were taken at ripe stage. Sensory score was also recorded at ripe stage. 5 fruits were randomly selected from each replication of each treatment and analyzed to determine the fruit chemical composition (TSS, total sugar, reducing, non-reducing, titrable acidity, ascorbic acid, chlorophyll content and carotene content) at ripe stage according to [10]. The data obtained was analyzed statistically as per the method suggested by [11]. The standard error of mean (S.E.m.) was worked out and the critical difference (C.D.) at 5 per cent was calculated whenever the results were found significant.

3. RESULTS AND DISCUSSION

3.1 Total Soluble Solid (°BRIX)

Data presented in Table 1 indicated that the different bagging treatments were unable to produce any significant impact on TSS, but numerically maximum and minimum TSS were recorded in a brown paper bag (19.91°B) and in the control condition (18.64°B), respectively. Huang et al. [12] In pear CV. Meirensu, Watanawan et al. [13] In mango CV. Nam Dok Mai 4 and Hofman et al. [6] in mango cv. Keitt reported that fruit bagging did not affect (TSS) significantly. While different varieties had a significant effect. Significantly maximum and

minimum TSS were recorded in Kesar (20.58°B) and Vanraj (18.37°B) varieties, respectively. The interaction between different bagging treatments and varieties was found to be non-significant with TSS.

3.2 Total Sugar (%)

The nonsignificant effect of bagging treatments was recorded on total sugar. Xiao ling et al. [14] in mango cv. Keitt and Ding and Syakirah [15] in mango cv. Harumanis observed similar trend. While significantly maximum total sugar was recorded in Alphonso variety (14.15%). The minimum total sugar was recorded in Vanraj variety (10.67%). This might be due to release of sugar by the hydrolysis of starch in Alphonso (V₂) variety of sugars. Influence of different bagging treatment and their interaction with varieties of total sugar were found non-significant.

3.3 Reducing Sugar (%)

Reducing sugar was non-significant differed by bagging treatment, however numerically highest reducing sugar recorded in a brown paper bag (3.62%). These findings of bagging on reducing sugar were also recorded by Xiao Lin et al. [14] in mango cv. Keitt and Watanawan et al. [13] cv. Nam Dok Mai 4 mango. While Alphonso variety (V₂) showed significantly maximum reducing sugar (4.04%). The minimum reducing sugar (3.12%) was recorded in Vanraj variety (V₄). It might be due to fast hydrolysis of starch ultimately higher content of reducing sugar in an Alphonso variety (V₂) of mango. The interaction of different bagging treatment with varieties was found non-significant for reducing sugar.

3.4 Non-Reducing Sugar (%)

Fruit bagging found non-significant in respect of non-reducing sugar. The range of non-reducing sugar was recorded maximum to minimum in brown paper (9.07%) to the white paper (T₄) bagged fruits, respectively, which was the upper and lower limit of non-reducing sugar. Watanawan et al. [13] in mango cv. Nam Dok Mai 4. While significantly maximum non-reducing sugar was recorded in Alphonso variety (10.11%). The minimum non-reducing sugar was noted in Vanraj variety (7.54%). This might be due to higher respiration rate and enzymatic activity in an Alphonso variety (V₂) of mango. However, the effect of different bagging treatment and their interaction were found non-significant.

Table 1. Effect of different bagging materials on TSS (°B), total sugar (%), reducing sugar (%), non-reducing sugar (%), titrable acidity (%) and ascorbic acid (mg/100 g) of fruit of different mango varieties

Treatment	TSS (°B)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Titrable acidity (%)	Ascorbic acid (mg/100 g of pulp)
Colour paper bag (T)						
T ₁ - Brown	19.91	12.70	3.62	9.07	0.18	22.21
T ₂ - Old newspaper	19.74	12.47	3.60	8.87	0.17	22.02
T ₃ - Yellow	19.57	12.65	3.56	9.04	0.17	21.24
T ₄ - White	19.61	12.31	3.54	8.77	0.17	20.99
T ₅ - Control	18.64	12.26	3.42	8.79	0.16	20.50
S.Em.±	0.358	0.25	0.088	0.26	0.004	0.77
C.D. at 5%	NS	NS	NS	NS	NS	NS
Varieties (V)						
V ₁ - Kesar	20.58	13.50	3.82	9.68	0.19	21.47
V ₂ - Alphonso	19.85	14.15	4.04	10.11	0.18	22.23
V ₃ - Langra	19.36	11.58	3.21	8.30	0.16	21.28
V ₄ - Vanraj	18.37	10.67	3.12	7.54	0.16	20.59
S.Em.±	0.320	0.22	0.079	0.24	0.005	0.69
C.D. at 5%	0.908	0.64	0.22	0.68	0.012	1.96
Interaction effect (T×V)						
S.Em.±	0.717	0.51	0.177	0.53	0.012	1.55
C.D. at 5%	NS	NS	NS	NS	NS	NS
CV%	7.34	8.18	9.94	12.10	11.68	8.08

3.5 Titrable Acidity (%)

The nonsignificant effect of fruit bagging in respect of titrable acidity (%) was recorded. Maximum titrable acidity was recorded on brown paper bagged fruits (0.18%) whereas, the minimum titrable acidity was observed in unbagged fruits (0.16%). Similar results were recorded by Xiao Lin et al. [14] in mango cv. Keitt, Watanawan et al. [13] in mango cv. Nam Dok Mai 4, Harach and Wanichkul [16] in guava cv. Yen Song and Hofman et al. [6] in mango cv. Keitt. While in case of different varieties, the lowest titrable acidity was recorded in Vanraj (0.16%) as well as Langra variety (0.16%). The titrable acidity was recorded significantly highest in Kesar variety (0.18%). This might be due to accelerated utilization of acid in the process of respiration during ripening in Kesar variety (V₁) of mango. The titrable acidity was not significantly affected by the interaction of different bagging treatment with varieties.

3.6 Ascorbic Acid (mg/100 g of Pulp)

Ascorbic acid showed non-significant effect of bagging, but numerically highest and lowest ascorbic acid was recorded on brown paper (T₁)

and unbagged (T₅) fruits, respectively. Same were reported by Xiao ling et al. [14] in mango cv. Keitt, Ding and Syakirah [15] in mango cv. Harumanis and Watanawan et al. [13] in mango cv. Nam Dok Mai 4. Significantly maximum and minimum ascorbic acid were recorded in Alphonso (22.23 mg/100 g of pulp) and Vanraj (20.59 mg/100g of pulp) varieties, respectively. This might be due to varietal characters. The interaction of different bagging treatment with varieties was found non-significant with respect to ascorbic acid.

3.7 Chlorophyll Content (µg/g of Tissue)

The effected range of chlorophyll of harvested mango fruits by different bagging materials and varieties is exhibited in Table 2. Chlorophyll content was recorded significantly highest in unbagged fruits (3.85 µg/g of tissue). While, significantly the lowest chlorophyll content was recorded in brown paper bagged fruits (2.78 µg/g of tissue). It might be due to less contact of direct sunlight to the paper bagged mango fruit. The Vanraj variety (4.48 µg/g of tissue) recorded significantly highest chlorophyll content. The least chlorophyll content was observed in Langra variety (2.44 µg/g of tissue).

Table 2. Effect of different bagging materials on chlorophyll ($\mu\text{g/g}$ of tissue) of fruit of different mango varieties

Treatments Varieties (V)	Chlorophyll ($\mu\text{g/g}$ of tissue)					V mean
	Colour paper bag (T)					
	Brown	Old newspaper	Yellow	White	Control	
V ₁ - Kesar	2.30	2.40	3.20	3.40	3.80	3.02
V ₂ - Alphonso	3.10	3.40	3.50	3.70	3.30	3.40
V ₃ - Langra	1.60	2.40	2.10	2.60	3.50	2.44
V ₄ - Vanraj	4.10	4.40	4.50	4.60	4.80	4.48
T mean	2.78	3.15	3.33	3.58	3.85	
SOV	Paper bag colour (T)		Varieties (V)		T x V	
S. Em\pm	0.40		0.40		0.80	
C. D. at 5%	1.0		1.0		2.0	
C. V. %	14.77					

In the interaction of different bagging treatment with varieties, significantly maximum chlorophyll content ($4.80 \mu\text{g/g}$ of tissue) was recorded in Vanraj which was unbagged fruits (V_4T_5). The results are accordance with Hongxia et al. [10] that fruit bagged with single white bags displayed significantly lower content of chlorophylls.

carotenoides ($5.60 \mu\text{g/g}$ of tissue). Whereas, minimum carotenoides ($1.60 \mu\text{g/g}$ of tissue) were recorded in the interaction of Vanraj variables and brown paper bag (V_4T_1). Hongxia et al. [17] reported that fruit bagged with single white bags displayed significantly lower content of chlorophyll and carotenoids.

3.8 Carotenoides Content ($\mu\text{g/g}$ of Tissue)

Among different bagging treatments, significantly maximum carotenoid content was recorded in brown bagged fruits ($4.07 \mu\text{g/g}$ of tissue). Whereas, the minimum carotenoid content was observed in unbagged fruits ($2.45 \mu\text{g/g}$ of tissue). It might be due to the poor pigmentation in Vanraj variety of mango (V_4). The carotenoid content of mango was significantly affected by varieties. It was recorded maximum in Kesar variety ($3.90 \mu\text{g/g}$ of tissue). The minimum carotenoides was recorded in Vanraj variety ($2.10 \mu\text{g/g}$ of tissue).

The interaction of Kesar fruits and brown paper bag (V_1T_1) recorded significantly maximum

3.9 Sensory Evaluation

Brown paper bag (T_1) recorded significantly highest pulp color (7.33) and test score (7.47), same type of result was reported by Signes et al. [18]. Significantly maximum pulp colour (7.42), texture (7.63), taste (7.55) and flavor (7.50) was recorded in Kesar variety (V_1), whereas, in Vanraj variety (V_4) was observed minimum.

In the interaction of different bagging treatment with varieties, found non-significant. Highest pulp color, texture, taste and flavor recorded in Kesar fruits with brown paper bag (V_1T_1). Whereas lowest pulp color, texture, taste and flavor was recorded in Vanraj fruits which was unplugged (V_4T_5). The same result of non significant

Table 3. Effect of different bagging materials on carotenoids ($\mu\text{g/g}$ of tissue) of fruit of different mango varieties

Treatments Varieties (V)	Carotenoids ($\mu\text{g/g}$ of tissue)					V mean
	Colour paper bag (T)					
	Brown	Old newspaper	Yellow	White	Control	
V ₁ - Kesar	5.60	4.40	3.50	3.70	2.60	3.90
V ₂ - Alphonso	3.70	3.10	4.30	3.50	1.70	3.20
V ₃ - Langra	5.40	4.50	2.70	2.05	2.70	3.60
V ₄ - Vanraj	1.60	2.40	2.40	1.70	2.80	2.10
T mean	4.07	3.60	3.20	2.80	2.45	
SOV	Paper bag colour (T)		Varieties (V)		T x V	
S. Em\pm	0.10		0.10		0.10	
C. D. at 5%	0.20		0.20		0.40	
C. V. %	9.17					

Table 4. Effect of different bagging materials on sensory evaluation of fruit of different mango varieties

Treatment	Pulp colour	Texture	Taste	Flavor
Colour paper bag (T)				
T ₁ - Brown	7.33	7.50	7.47	7.28
T ₂ - Old newspaper	7.03	7.42	7.03	7.22
T ₃ - Yellow	7.12	7.34	7.19	7.25
T ₄ - White	6.80	7.40	6.93	6.50
T ₅ - Control	6.40	6.27	6.75	6.69
S.Em.±	0.218	0.120	0.148	0.241
C.D. at 5%	0.617	NS	0.419	NS
Varieties (V)				
V ₁ - Kesar	7.42	7.63	7.55	7.50
V ₂ - Alphonso	7.04	7.61	7.27	7.17
V ₃ - Langra	6.74	7.33	6.92	6.87
V ₄ - Vanraj	6.55	6.97	6.55	6.40
S.Em.±	0.195	0.108	0.132	0.215
C.D. at 5%	0.553	0.306	0.375	0.611
Interaction effect (T×V)				
S.Em.±	0.436	0.241	0.296	0.482
C.D. at 5%	NS	NS	NS	NS
CV%	12.58	6.54	8.35	13.65

effect of bagging on color, taste, texture and flavor was obtained by Watanawan et al. [13] in mango cv. Nam dok mai 4.

4. CONCLUSION

It is concluded from the present study that Pre-harvest fruit bagging is a farmer friendly practice to ensure the quality and physical appearance of the fruit. It is easy and safe practice that protects fruit from diseases and insect pests. Under South Gujarat condition, Fruit bagging with brown paper bag at marble stage gave better results in all of the parameters. Kesar and Alphonso variety showed better results in respect of the parameters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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