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Studies on Influence of Bagging of Fruits at Marble Stage on Quality of Mango cv. Alphonso

P. M. Haldankar[1], Y. R. Parulekar[1], Alwala Kireeti[1], M. S. Kad[1], S. M. Shinde[1] & K. E. Lawande[2]

[1] Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.), 415712, India

[2] Ex.Vice Chancellor, Dr. B. S. K. K. V., Dapoli, Dist. Ratnagiri (M.S.), 415712, India

Correspondance: P. M. Haldankar, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.), 415712, India. Tel: 91-942-180-9721. E-mail: parag5663@rediffmail.com; paraghaldankar@yahoo.co.in

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Abstract

Preharvest fruit bagging has emerged as a novel technology in practice, which is simple, grower friendly, safe and beneficial for production of quality fruits. An investigation was undertaken in 2013 and 2014 for two consecutive fruiting seasons entitled studies on influence of bagging of fruits at marble stage on quality of mango cv. Alphonso. The fruits were bagged at marble stage (30 days from fruit set) with different types of bags which constituted the various treatments *viz*: T_1: Newspaper bag; T_2: Brown paper bag; T_3: Scurting bag; T_4: Polythene bag; T_5: Butter paper bag; T_6: Muslin cloth bag; T_7: Brown paper bag with polythene coating; T_8: control (no bagging). The experiment was conducted in Randomised Block Design with eight treatments replicated three times. The preharvest bagging modified fruit retention, period required for harvesting after bagging, physico-chemical composition of mature and ripe fruit, shelf life, occurrence of spongy tissue and pest incidence. Bagging with newspaper bag and brown paper bag improved fruit retention, weight of fruit, diameter of fruit, pulp weight, total soluble solids and reducing sugars at ripe stage and produced spongy tissue free fruits. The brown paper bag with polythene coating improved fruit retention, weight of fruit, pulp weight and decreased occurrence of spongy tissue and incidence of mealy bag. The butter paper bag, muslin cloth bag and scurting bag improved fruit retention, reduced occurrence of spongy tissue and incidence of mealy bag. Preharvest bagging with different types of bag did not change the sensory qualities of ripe fruits mango cv. Alphonso.

Keywords: mango (*Mangifera indica* L.), 'Alphonso', marble stage, bagging, fruit retention, physico-chemical composition, spongy tissue

1. Introduction

Mango (*Mangifera indica* L.) is the 'National Fruit' of India. Among the different varieties dominantly cultivated in India, Alphonso is the choicest variety. It is especially preferred for its exemplary flavour, attractive golden yellow fruit colour, orange flesh colour, good keeping quality and excellent processing properties. The Konkan region of Maharashtra is one of the major mango growing belts in India. Mango is established in Konkan on 1.85 lakh hectares of which about 90 per cent is occupied by 'Alphonso' (Haldankar et al., 2013). 'Alphonso' is the major source of economy and livelihood in this region. An attractive, spotless and pest free fruits of this variety fetch premium rate in the market. In recent years, the climatic aberrations such as sudden rise in the temperature and humidity, abnormal rains especially during fruit development are often experienced. It had not only affected the external appearance of the fruit but also aggravated the pest such as mealy bugs and physiological disorder like spongy tissue which further added in the losses. The affected fruits gain poor price in the market and such fruits are also rejected for processing. It causes serious economic loss to mango growers. Recently, the pre harvest bagging technique of fruits has shown promise in the fruits like banana, litchi and apple (Sharma, Reddy, & Jhalegar, 2014). It provides physical barrier over fruit and prevent mechanical damage and bruises to fruit, protect the fruit from pest and diseases and also help for appropriate fruit development (Sharma et al., 2014). Several types of locally available materials can be used for bagging. However, the technique is seldom attempted in mango in India and specifically in Alphonso under Konkan agro climatic conditions. Hence, an experiment was undertaken to study the influence of bagging of fruits at marble stage on quality of mango cv. Alphonso.

2. Materials and Methods

The trial was conducted in the mango orchard of cv. Alphonso at Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (MS) India, 415712 from 2013 and 2014 for consecutive two years during February to May. The soil of experimental plot was red lateritic with uniform depth and good drainage conditions. Uniformly grown 18 year old Alphonso mango grafted trees were selected. The experiment was conducted in Randomised Block Design with eight treatments replicated three times with a unit of 40 fruits per treatment per replication. Different types of bags constituted the treatments *viz*.: T_1: News paper bag; T_2: Brown paper bag; T_3: Scurting bag; T_4: Polythene bag; T_5: Butter paper bag; T_6: Muslin cloth bag; T_7: Brown paper bag with polythene coating; T_8: control (no bagging). Uniformly grown fruits at marble stage (30 days after fruit set) were selected for bagging. The size of bags was 25 × 20 cm. Before bagging six perforations (≤ 4 mm diameter) were made for proper ventilation at the bottom of all bags except for scurting and muslin cloth bags. The particular bags were stapled properly at the stalk of each fruit of respective treatments so that it would not be fall down as well as there would not be open space. The scurting and muslin cloth bags were tied with the help of thread. The observations *viz.* fruit retention (%) and day's require for harvesting after bagging were recorded. Four fruits were randomly selected per treatment per replication to record various physical and chemical observations. The physical and chemical composition was estimated by the following procedures

2.1 Length and Diameter of Fruit (cm)

The length from stalk end to the apex of fruit and diameter was measured with the help of digital Vernier calliper and expressed in centimeters (cm).

2.2 Fruit Weight and Pulp Weight (g)

The weight of fruit was recorded by using monopan electronic balance and expressed in grams (g). Then the pulp weight was meseared by same method.

2.3 Total Soluble Solid (TSS)

5g pulp of was crushed in mortar and pestle which was transferred to 100 ml beaker and diluted in 1:2 proportions with distilled water. Total soluble solids were found out by using Erma Hand Refractometer (0 to 32°Brix) and expressed in ^{o}Brix (A.O.A.C., 1980).

2.4 Citric Acid (%)

5g pulp of was crushed in mortar and pestle and transferred to 100 ml volumetric flask. Distilled water was added to make volume up to 100 ml. Then the sample was filtered and 25 ml filtrate was taken in the beaker and was titrated against 0.1N NaOH using phenolphthalein as an indicator. The results were expressed in percent of citric acid (Ranganna, 1997).

2.5 Reducing Sugars

5 g of pulp was crushed in mortar and pestle. It was transferred to 250 ml volumetric flask. To this, 100 ml of distilled water was added and the contents were neutralized by 1N Sodium Hydroxide. Then, 2 ml of 45 per cent lead acetate was added to it. The contents were mixed well and kept for 10 minutes. Appropriate quantity (2.5 ml) of 22 per cent potassium oxalate was added to it to precipitate the excess of lead. The volume was made to 250 ml with distilled water and solution was filtered through Whatman No.40 filter paper. Determination of reducing sugars was done by the method of Lane and Eynon (1923) as described by Ranganna (1997). The results were expressed on per cent basis.

2.6 Total Sugars

In 100 ml volumetric flask, 50 ml of diluted sample prepared for reducing sugar estimation was taken. To this, 5 ml HCl (1:1) was added and allowed to stand at room temperature for 24 hours. The flask was then kept in thermostatic water bath at 70 ºC to 80 ºC temperature for 30 minutes. The hydrolysed sample was neutralized by adding pinch of Sodium Carbonate till formation of effervescence stopped. After cooling, the volume was adjusted to 100 ml with distilled water. This sample was used for determination of total sugars by the method of Lane and Eynon (1923) as described by Ranganna (1997).

2.7 Ascorbic Acid (mg/100g of Fruit Pulp)

Determination of ascorbic acid was done by 2, 6 - dichlorophenol indophenol dye method of Johnson (1948) as described by Ranganna (1997). 5 ml of sample was blended with 3 per cent metaphosphoric acid (HPO_3) to make the final volume of 100 ml and then filtered. 25 ml quantity of aliquot was titrated against 0.025 per cent 2,

6 - dichlorophenol indophenol dye to a pink colour end point. The ascorbic acid content of the sample was calculated taking into consideration the dye factor and expressed as mg ascorbic acid per 100 g fruit pulp.

2.8 β - carotene (µg/100 g of Pulp)

Total carotenoid pigments (expressed as β–carotene) were determined as per the method described by Roy (1973) as described by Ranganna (1997). The results were expressed in terms of β– carotene as µg/100 g sample.

2.9 Shelf Life of Fruits (Days)

The end of shelf life was noted when the fruits were spoiled.

The mature fruits were harvested at 80 - 85 percent maturity. Twenty harvested mature fruits of each treatment were ripened at ambient temperature by using traditional paddy straw as ripening material. In this method plastic crates with perforation were used. At the bottom, 2.5 cm layer of paddy straw was made on which fruit were arranged. Simultaneously, two more layers were kept on the first layer. After ripening the various observations *viz*. shelf life (days) and incidence of spongy tissue (%) were recorded. The end of shelf life was noted when the fruits were spoiled. The chemical compositions *viz*. TSS (^{o} Brix), acidity (%), reducing sugars (%) and total sugars (%) were estimated by the above given procedures. The observations on incidence of mealy bug (%) were recorded. The ripe fruits were also examined for their sensory qualities for assessing colour, flavour and texture by panel of five judges with nine point Hedonic Scale *viz*.1-Dislike extremely, 2-Dislike very much, 3-Dislike moderately, 4-Dislike slightly, 6-Like slightly, 7-Like moderately, 8-Like very much and 9-Like extremely (Amerine, Pangborn, & Rocssler, 1965).

3. Statistical Analysis

The statistical analysis was performed as per the ANOVA suggested by Panse and Sukhatme (1997). The P values of data were estimated by students paired T-Test. SD was computed as per the procedure advocated by Rangaswamy (1995).

4. Results and Discussion

Fruit retention was significantly improved by pre-harvest bagging with newspaper bag (71.25%), brown paper bag (71.67%) and scurting bag (71.67%) over control (Table 1). The fruit retention found in butter paper bag (68.75%), muslin cloth bag (68.58%) and brown paper bag with polythene coating (67.92%) was also higher than control but the difference was non-significant. The harvesting was significantly preponed in polythene bag, scurting bag, butter paper bag, muslin cloth bag whereas in newspaper bag, it was significantly delayed. The polythene bag (62.50 days) took minimum days for harvest after bagging. The treatments newspaper bag, butter paper bag, muslin cloth bag, brown paper bag and brown paper bag with polythene coating were at par with control (65.00 days) for days required for harvest after bagging. The abiotic factors *viz*. temperature and humidity play critical role in fruit growth and development. Bagging on fruits alters the microenvironment around fruits (Sharma et al., 2014). The early harvesting of fruits bagged with polythene bag and delay in harvesting of fruits bagged with news paper bag has been reported in Tomato, Litchi and Fuji Supreme Apple (Leite et al., 2014; Debnath & Mitra, 2007; Fallahi, Colt, Baird, & Chun, 2001).

Table 1. Effect of types of bag on fruit retention and days required for harvesting after bagging in mango fruit cv. Alphonso (2013-2014)

Treatments	Fruit retention (%)	Days required for harvesting after bagging
Newspaper bag	71.25	67.5
	(71.25±0)	(67.50±0)
Brown paper bag	71.67	66
	(71.67±0.72)	(66± 0)
Scurting bag	71.67	64.5
	(71.67± 1.90)	(64.50± 0)
Plastic bag with perforations	65	62.5
	(65± 0.72)	(62.50± 0)
Butter paper bag	68.75	64.5
	(68.75± 1.44)	(64.50±2)
Muslin cloth bag	68.58	64.5
	(68.58± 2.62)	(64.50± 0)
Brown paper bag with polythene coating	67.92	66
No Bagging	(67.92± 2.16)	(66± 0)
	66.25	65
Range	(66.25± 0.72)	(65±2.5)
Mean	65.00-71.67	62.50-67.50
S. Em ±	68.88	65.06
C. D. at 5%	0.86	0.61
P – Value	2.61	1.84
	0.000385	0.002389

Preharvest bagging with newspaper bag, brown paper bag and brown paper bag with polythene coating improved physical parameters *viz*: weight of fruit, length of fruit, diameter of fruit and pulp weight over unbagged control fruits, and the variation was statistically significant (Table 2). The fruits bagged in polythene bag produced the smallest fruit having (225.78 g) fruit weight and diameter of (7.43 cm). The polythene bag exhibited the fruits with best pulp to stone ratio (6.76). Preharvest bagging with newspaper bag, butter paper bag and muslin cloth bag also recorded superior pulp to stone ratio over unbagged control fruits. Covering fruit with a bag at a particular developmental stage may influence their growth and size. Reports on effects of fruit bagging on fruit size and weight opined that it may be due to differences in the type of bag used, fruit and cultivar responses. (Sharma et al., 2014). Bagging 'Nam Dok Mai 4' mango fruit with two-layer paper bags, newspaper, or golden paper bags increased fruit weight. (A. Watanawan, C. Watanawan, & Jarunate, 2008). Bagging increased fruit weight, size over unbagged control fruits. (Chonhenchob et al., 2011). Microenvironment created by news paper bag, brown paper bag and brown paper bag with polythene coating might have congenial effect on fruit growth of mango cv. Alphonso. All these three treatments recorded more period for harvesting than that of unbagged control fruits. The fruits bagged in polythene bag were harvested earlier than those of unbagged fruits. The preharvest bagging was found beneficial to increase to fruit weight of BC-2, Fuji Apple (Fallahi et al., 2001). Bagging promoted longan fruit development, resulting in larger-sized fruit (Yang et al., 2009).

Table 2. Effect of types of bag on physical parameters of mango cv. Alphonso (2013-2014)

Treatments	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)	Pulp weight (g)	Stone weight (g)	Pulp: stone ratio
Newspaper bag	264.07	8.87	7.79	206.55	32.89	6.37
	(264.07±10)	(8.87±0.14)	(7.79±0.10)	(206.55±9.09)	(32.89±1.81)	(6.37±0.03)
Brown paper bag	254.47	8.89	7.74	195.21	33.69	5.8
	(254.47± 8.48)	(8.89±0.13)	(7.74±0.12)	(195.21±8.91)	(33.69±0.87)	(5.80±0.07)
Scurting bag	243.53	8.53	7.56	185.79	31.15	5.98
	(243.53± 6.48)	(8.53±0.10)	(7.56± 0.02)	(185.79±3.77)	(31.15±1.04)	(5.98±0.02)
Plastic bag with perforations	225.78	8.37	7.43	182.57	28.78	6.76
	(225.78±15.38)	(8.37±0.25)	(7.43±0.26)	(182.57±11.07)	(28.78±0.74)	(6.76±0.05)
Butter paper bag	245.65	8.61	7.59	192.14	33.07	6.25
	(245.65±25.88)	(8.61±0.14)	(7.59± 0.12)	(192.14±5.81)	(33.07±0.57)	(6.25±0.10)
Muslin cloth bag	239.24	8.5	7.63	187.96	30.56	6.15
	(239.24± 4.14)	(8.50±0.03)	(7.63±0.05)	(187.96±3.95)	(30.56±0.20)	(6.15±0.02)
Brown paper bag with polythene coating	251.37	8.74	7.69	194.47	34.72	5.7
	(251.37±11.95)	(8.74±0.15)	(7.69±0.14)	(194.47±8.04)	(34.72±1.90)	(5.70±0.04)
No Bagging	232.46	8.3	7.45	180.62	31.06	5.92
	(232.46± 4.88)	(8.30±0.15)	(7.45± 0.10)	(180.62±4.89)	(31.06±0.77)	(5.92±0.07)
Range	225.78-264.07	8.30-8.89	7.43-7.79	180.62-206.55	28.78-34.72	5.70-6.76
Mean	244.57	8.6	7.6	190.66	31.98	6.11
S. Em ±	4.98	0.08	0.05	3.97	0.63	0.03
C. D. at 5%	15.09	0.26	0.17	12.04	1.91	0.09
P - Value	0.0020874	0.0014875	0.0083438	0.008764	0.000219	0.0000001

The pre-harvest bagging had non-significant effect on total sugars and ascorbic acid content of fruits at harvest (Table 3). The unbagged control fruits recorded the highest acidity (3.45%) and TSS (7.82 ^{o}Brix) which was significantly superior over all bagging treatments. The fruits of treatment polythene bag had significantly highest reducing sugars and βeta carotene. The variation observed in chemical composition of mango fruits can be attributed to the changed microenvironment around fruit during its growth and development. The bagged fruits recorded highest content of vitamin C, sucrose, glucose and fructose over control in Zill mango (Hongxia et al., 2009). The bagging of date palm fruits improved the total sugars (Harhash & Al-Obeed, 2010). Bagging enhanced carotenoid content in mango (Zhao, Wang, Zhang, Huan, & Gao, 2013).

Table 3. Effect of types of bag on chemical composition of mango cv. Alphonso fruit at harvest (2013-2014)

Treatments	Citric acid (%)	TSS (°Brix)	Reducing sugars (%)	Total sugars (%)	Ascorbic acid (mg/100 g)	β – carotene (µg /100 g)
Newspaper bag	2.97 (2.97±0.01)	7.46 (7.46±011)	1.13 (1.13±0.01)	2.13 (2.13±0.19)	76.81 (76.81±1.26)	312.1 (312.10±2.05)
Brown paper bag	3.01 (3.01±0.02)	7.44 (7.44±0.10)	1.21 (1.21±0.02)	1.97 (1.97±0.26)	77.36 (77.36±0.87)	306.75 (306.75± 3.12)
Scurting bag	3.39 (3.39±0.05)	7.61 (7.61±0.04)	1.16 (1.16±0.05)	2.3 (2.30±0.43)	75.78 (75.78±0.41)	316.58 (316.58± 1.23)
Plastic bag with perforations	2.89 (2.89±0.01)	7.58 (7.58±0.02)	1.35 (1.35±0.07)	1.92 (1.92±0.48)	74.77 (74.77±2.08)	317.56 (317.56± 0.71)
Butter paper bag	3.24 (3.24±0.02)	7.4 (7.40±0.02)	1.2 (1.20± 0.06)	1.75 (1.75±0.09)	77.97 (77.97±0.89)	311.51 (311.51± 1.86)
Muslin cloth bag	2.9 (2.90±0.04)	7.56 (7.56±0.12)	1.06 (1.06± 0.03)	1.7 (1.70±0.22)	76.84 (76.84±0.62)	312.76 (312.76± 1.82)
Brown paper bag with polythene coating	3.01 (3.01±0.03)	7.5 (7.50±0.02)	1.16 (1.16± 0.02)	1.89 (1.89±0.01)	74.05 (74.05±0.68)	309.45 (309.45± 2.52)
No Bagging	3.44 (3.44±0.04)	7.82 (7.82±0.05)	1.12 (1.12± 0.01)	2.03 (2.03±0.02)	76.74 (76.74±1.50)	310.63 (310.63± 4.24)
Range	2.89-3.44	7.40-7.82	1.06-1.35	1.70-2.30	74.05-77.97	306.75-317.56
Mean	3.1	7.54	1.17	1.96	76.28	312.16
S. Em ±	0.02	0.04	0.02	0.16	0.69	1.47
C. D. at 5%	0.06	0.13	0.07	NS	NS	4.46
P - Value	0.00000000001	0.000284	0.000052	0.263963	0.018502	0.002539

Fruits of newspaper bag exhibited the maximum TSS (16.10 ^{o}Brix) and reducing sugars (2.06%) at ripe stage (Table 4). It was followed by brown paper bag (15.99 ^{o}Brix, 2.05%). Fruits of polythene bag (0.44%) had maximum acidity followed by brown paper bag with polythene coating (0.43%), control (0.39%) and butter paper bag (0.37%) which were at par with each other. brown paper bag with polythene coating (7.48%) recorded the maximum total sugars which was significant whereas muslin cloth bag displayed the maximum ascorbic acid and βeta carotene at ripe stage. Sensory evaluation with respect to colour, flavour, texture was non-significant among various treatments under study. It indicated that the organoleptic qualities of fruit were not affected by pre-harvest bagging in mango cv. Alphonso. The bagging led to lower contents of chemical components such as sugar, phenols and organic acids in most of peach varieties (Lima, Angelo, Marcelo, Deyse, & Elisa, 2013). Fruit firmness was slightly increased by bagging treatments, whereas soluble solids content was decreased in apple (Feng, Mingjun, Fengwang, & Lailiang, 2014).

Table 4. Effect of types of bag on chemical composition and sensory evaluation of mango cv. Alphonso fruit at ripe stage (2013-2014)

Treatments	Citric acid (%)	TSS (°Brix)	Reducing sugar (%)	Total sugars (%)	Ascorbic acid (mg/100g)	β – carotene (µg /100 g)	Sensory Evaluation		
							Colour	Flavour	Texture
Newspaper bag	0.36 (0.36±0.01)	16.1 (16.10±0.37)	2.06 (2.06±0.12)	6.49 (6.49±0.01)	52.95 (52.95±0.78)	11143.69 (11143.69±260.59)	8 (8±0.25)	7.67 (7.67±0.14)	7.67 (7.67±0.38)
Brown paper bag	0.3 (0.30±0.02)	15.99 (15.99±0.49)	2.05 (2.05±0.03)	6.78 (6.78±0.16)	53.44 (53.44±0.09)	11067.61 (11067.61± 131.89)	8 (8±0.25)	7.83 (7.83±0.38)	7.83 (7.83±0.14)
Scurting bag	0.33 (0.33±0.01)	15.61 (15.61±0.34)	1.87 (1.87±0.04)	6.48 (6.48±0.09)	53.19 (53.19±0.19)	11533.38 (11533.38± 186.57)	7.75 (7.75±0.25)	7.75 (7.75±0.25)	7.83 (7.83±0.14)
Plastic bag with perforations	0.44 (0.44±0.03)	15.24 (15.24±0.15)	1.88 (1.88±0.03)	6.98 (6.98±0.02)	54.54 (54.54±0.63)	11572.08 (11572.08± 83.75)	7.5 (7.50±0.5)	7.58 (7.58±0.72)	8 (8±00)
Butter paper bag	0.37 (0.37±0.01)	15.78 (15.78±0.22)	2 (2.06±0.06)	6.43 (6.43±0.04)	52.66 (52.66±0.26)	11335.26 (11335.26± 95.76)	8 (8±0.25)	8.08 (8.08±0.14)	7.92 (7.92±0.29)
Muslin cloth bag	0.35 (0.35±0.02)	15.82 (15.82±0.24)	1.87 (1.87±0.04)	6.99 (6.99±0.04)	55.54 (55.54±0.32)	11754.34 (11754.34± 157.59)	8 (8±00)	7.92 (7.92±0.38)	8 (8±0.25)
Brown paper bag with polythene coating	0.43 (0.43±0.01)	15.85 (15.85±0.23)	1.97 (1.97±0.11)	7.48 (7.48±0.06)	53.94 (53.94±0.21)	11236.37 (11236.37± 58.42)	8 (8±0.5)	8 (8±0.5)	8.08 (8.08±0.29
No Bagging	0.39 (0.39±0.02)	15.64 (15.64±0.61)	1.86 (1.86±0.04)	6.81 (6.81±0.10)	52.73 (52.73±0.47)	11099.79 (11099.79± 271.45)	8 (8±0.43)	7.75 (7.75±0.5)	7.75 (7.75±0.43)
Range	0.30-0.44	15.24-16.10	1.86-2.06	6.43-7.48	52.66-55.54	11067.61-11754.34	7.50-8	7.58-8.08	7.67-8.08
Mean	0.37	15.75	1.95	6.8	53.62	11342.82	7.91	7.82	7.89
S. Em ±	0.01	0.22	0.04	0.01	0.26	104.83	0.19	0.21	0.17
C. D. at 5%	0.03	0.65	0.12	0.03	0.79	317.96	NS	NS	NS
P - Value	3.1157E-06	0.254194	0.003788	0.000000008	0.0000193	0.002677	0.51941	0.703268	0.674265

The unbagged control fruits of 'Alphonso' had shelf life of 15 days (Table 5). The fruits of newspaper bag (17.50 days), brown paper bag (16.50 days), brown paper bag with polythene coating (16.00 days) and muslin cloth bag (15.00 days) had greater shelf life than control (15.00 days). The fruit of scurting bag (13.50 days) had shortest shelf life. All bagging treatments showed fewer incidence of mealy bags and spongy tissue as compared to control. The fruits bagged in newspaper bag were totally free from mealy bags as well as spongy tissue. The fruits of polythene bag and butter paper bag were free from mealy bugs, whereas fruits of brown paper bag were free from spongy tissue. The maximum incidence of mealy bugs (9.63%) and spongy tissue content (9.00%) was recorded in control. Bagging modified the microenvironment near fruit especially in respect to temperature and humidity. The humidity as well as temperature in plastic bag was greater than that in news paper bag. The longer shelf life of bagged fruits indicated that the effect of bagging persisted after ripening. Bagging provided physical barrier between fruit and pests. The spongy tissue disorder is associated with convective heat (Katrodia, 1989) and exposure of fruit to sunlight (Om & Prakash, 2004). Bagging provides protection against both which helped in reducing occurrence of spongy tissue in fruits. In mango cv. Keitt white paper bags at approximately 100 days before harvest reduced anthracnose and stem end rot (Hofman, Smith, Joyce, Johnson, & Meiburg, 1997).

Table 5. Effect of types of bag on chemical composition and sensory evaluation of mango cv. Alphonso fruit at ripe stage (2013-2014)

Treatments	Shelf life (days)	Mealy bugs (%)	Spongy tissue (%)
Newspaper bag	17.5 (17.50±2)	0	0
Brown paper bag	16.5 (16.50±0)	4.17 (4.17±0)	0
Scurting bag	15 (15±0)	1.67 (1.67±0)	1.72 (1.72±0.48)
Plastic bag with perforations	13.5 (13.50±0)	0	6.17 (6.17± 1)
Butter paper bag	14.5 (14.50±0)	0	0.67 (0.67± 0)
Muslin cloth bag	15.5 (15.50±0)	2.84 (2.84±0)	0.84 (0.84±0)
Brown paper bag with polythene coating	16 (16±0)	3.33 (3.33±0)	2.39 (2.39±0.96)
No Bagging	15 (15±1)	9.63 (9.63±2.24)	9 (9± 0)
Range	13.50-17.50	00-9.63	00-9.00
Mean	15.43	2.7	2.59
S. Em ±	0.43	0.46	0.27
C. D. at 5%	1.3	1.39	0.82
P - Value	0.0004431	0.00000001	0.0000000000049

5. Conclusion

Thus, investigation revealed that preharvest bagging at 30 days after fruit set with various types of bag modified fruit retention, period required for harvesting, physico-chemical composition, shelf life, occurrence of spongy tissue and pest incidence in mango cv. Alphonso. Bagging with newspaper bag and brown paper bag improved fruit retention, weight of fruit, diameter of fruit, pulp weight, total soluble solids and reducing sugars at ripe stage and produced spongy tissue free fruits. The brown paper bag with polythene coating improved fruit retention, weight of fruit, pulp weight and decreased occurrence of spongy tissue and incidence of mealy bag. The butter paper bag, muslin cloth bag and scurting bag improved fruit retention, reduced occurrence of spongy tissue and incidence of mealy bag. Preharvest bagging with different types of bag did not change the sensory qualities of ripe fruits of mango cv.Alphonso.

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