Technology And Application Of Edible Coatings For Reduction Of Losses And Extension Of Shelf Life Of Cantaloupe Melon Fruits

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ABSTRACT: Thirty-six (36) cantaloupe melon fruits were used for the weight loss and firmness level trial. Eighteen (18) fruits were coated with Natralife™ coating while the 18 of the fruits were not coated and were used as control fruits. Six fruits each of coated and uncoated fruits were stored in a cold store at 2°C, another six fruits each of coated and uncoated were stored at 9°C cold storage, while the other six fruits each of the coated and uncoated fruit were kept in shelf life room of 20°C and a relative humidity of 85-90% for 30 days. The coating of melons with Natralife™ coatings was by hand brushing with sponge and allowed for 30-45 minutes to dry under natural ventilation before been stored at the various storage conditions. In regard to weight loss Melon fruits coated with Natralife™ coating had a signficant effect at 0.05% on weight loss stored at cold storage of 2°C and 9°C and shelf life room of 20°C and had reduced weight loss compared to uncoated control melons. Cantaloupe melon fruits stored at shelf life room of 20°C loss firmness at a rapid rate than fruits held at cold store of 2°C and 9°C. At cold store 2°C and 9°C, it was found that both coated and uncoated melons held at 2°C loss less firmness than fruit stored at 9°C cold store. Overall, Melon fruits coated and stored at 2°C perform better than fruits stored at 9°C and shelf-life room, while fruits held at 9°C did better than those stored at shelf-life room.

KEY WORDS: Edible coatings, cold storage, cantaloupe melon, weight loss, and firmness level.

Introduction

Melon (*Cucumis melo* L.) is an important commercial crop grown in many countries. It is produced in most temperate regions of the world, because of its ability to adapt to different soils and climate [17]. Cantaloupe melon is mostly consumed in the period of summer and is popular due to the refreshing pulp of the fruit and high nutrition content. [6]. report showed that the production of melon in Europe only, was more than three (3) million tons. The report indicated an increased in the production of melon in the continent and the world production in general. This reported increasing in production of melon presents a challenge for pack house operators and researchers to make more stable and safe produce from microbiological point of view. Edible coating such as Natralife™ is an alternative way of solving these problems. Edible coating is defined as a thin layer of material which provides a barrier to moisture, oxygen and solute movement and can be eaten as food [9]. The application of edible coating on fruits and vegetables have the same results compared to modified atmosphere packaging (MAP) as it modifies the gas composition [13]. Nasiru Alhassan is a lecturer at Wa Polytechnic in Ghana in the Postharvest Technology unit of the Agricultural Engineering Department.

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The right edible coating formulation could reduce water loss and gas exchange rates as well as represent an excellent way of incorporating additives to control reactions that are detrimental to produce quality during storage and transport [3]. Edible coating is made from proteins, lipids, polysaccharides, or from a combination of this group of materials [12]. In this regards, one material that can be used as a coating material is Natralife™ which contains active ingredients such as amino acids, minerals, vitamins, and enzymes. The use of Natralife™ coating provides a barrier to water and oxygen movement in fruits and has no effect to the taste [2]. Water loss during storage of melon can cause diseases and physiological disorders that can lead to economic losses. As such melons for a considerable long storage period should be coated with wax [1].However, the effects of waxes coatings on the quality of melon fruits are usually ignored because some waxes cause physical damage to the fruits. In spite of these short-comings, there has been some wax trial done on melons, some of the waxes were effective in reducing physiological disorders and diseases through the reduction of water loss while others were not effective. [10]. reported a decreased in firmness of cantaloupe melons held for 3 days at 15°C and 20°C compared to melons stored at 7°C**.** In a storage trial, [5]. tested polyethylene wax on reducing chilling injury in Honeydew melon stored at 3°C for up to 4 weeks. According to these authors, the coating did not only increased in firmness of fruit but decreased chilling injury of the fruit due to the reduction of water loss. However,[5] reported Semperfreh significantly increased the severity of brown speckle on the rind of the honeydew melon. Cantaloupe melon coated with citruseal wax had less weight loss, but anaerobic tissue breakdown occurred after 6 weeks of storage at 8°C and five days at 15-25°C, [11]. [15]. evaluated the effect of water wax coatings on cucumbers to reduce weight loss, however, cucumbers coated with water wax rather showed increased levels of ethanol methanol and acetaldehyde, indicating anaerobic respiration after 21 days of storage at 7°C. [6] tested the effectiveness of polyethylene wax (citruseal) on cucumber and Honeydew melon in storage at 4°C for 4 weeks. The authors found that citruseal wax induced anaerobic respiration in the cucumber and did not reduce breakdown caused by bacteria or fungi (Alterneria spp. and Fasarium) in Honeydew melon. Likewise, Semperfresh did not reduce the incidence of Alternaria rots in Honeydew melons. [16] evaluated the effects of ambient storage on Hami melon stored for 3 weeks, and observed that at higher temperatures Alternaria and Fasarium rots were significantly high. This result was similar to [4] findings, which also stored cantaloupe melon under ambient conditions for 21 days and established that at higher temperature during storage decays in melons are very high. Also [4] reported that at higher temperatures reduction of TSS in fruits occurred and could result in increase respiration of the fruits. [10] established that at the ripening stage of cantaloupe melon fruits the concentration of sugar declines with the onset of senescence. In another study, [18] stored Hami melon (cv. Kalakukai) between 0-2°C for 4 weeks. The melons were susceptible to chilling injury after the storage period. The work could not however find the relationships between temperature and time of the storage period. Therefore the aim of this research work is to investigate the ability of edible coating from Natralife™ to protect cantaloupe melon from deterioration and extent shelf-and-home-life.

Materials and Methods

The melons were harvested in Southern Spain on the 30th May 2008 and were sent on the 31st May 2008 to Organic Farm Food in United Kingdom. The fruits were held at Organic Farm Food for two (2) days before they were transported to Writtle College postharvest laboratory, United Kingdom on the 3rd June 2008. On arrival at the laboratory, the melons were stored in cold storage at 2°C for two days before the start of the trial on the 5th June 2008.

Design of the experiment

In all thirty-six (36) were used for the weight loss trialling. Eighteen (18) fruits were coated with Natralife™ coating while the 18 of the fruits were not coated and were used as control fruits. Six fruits each of coated and uncoated fruits were stored in a cold store at 2°C, another six fruits each of coated and uncoated were stored at 9°C cold storage, while the other six fruits each of the coated and uncoated fruit were kept in shelf life room of 20°C and a relative humidity of 85-90% for 30 days. The coating of melons with Natralife™ coatings was by hand brushing with sponge and allowed for 30-45 minutes to dry under natural ventilation before been stored at the various storage conditions. The melons were weighed and assessed for disease on the first day of the experiment. Fruits were arranged in a completely randomized design with two factorial treatments; 2% Natralife™ coating and storage temperature (2°C, 9°C and 20°C). Each treatment group comprised 6 replicated samples, each sample consisting of 6 fruits.

Determination of weight loss in cantaloupe melon

Weight of the fresh melon during the storage trial was measured by monitoring the weight of the fruit at 0, 2, 4, 6, 10, 14, 18, 22, 26 and 30 days. Weight was measured using weighing scale (JADEVER, JWE-30K; 30Kg x 1g). The weight of the melons were taken in every two (2) days for the first six days and subsequently weighed in every four (4) days to assess the percentage weight loss. The percent weight loss was computed using the following formula;

$$\text{Weight loss (\%)} = \frac{\text{Initial weight (kg)} - \text{Final weight (kg)}}{\text{Initial weight (kg)}} \times 100$$

Measurement of firmness level

The non-destructive method was used in measuring skin firmness. The firmness was measured on 0, 2, 4, 6, 10, 14, 18, 22, 26 and 30 days. The initial firmness levels were measured before treatment and storage. The firmness tested with a Shore meter was determined by the resistance average loss in firmness of skin in all 6 fruits in each replicate and expressed as average loss of firmness.

Measurement of total soluble solids in melon

The total soluble solid (TSS) content in the juice was measured on the day zero (0), day 15 and day 30 of the experiment to ascertain the level of Brix with the use of a hand held digital refractometer (model PAL-1, Atago, Italy). One fruit from each replicate was cut opened in each of the days and the Brix measured from two portions of the fruit, and the total soluble solid taken.

Evaluation of diseases and disorders of melon

Decay and physiological disorders were assessed on the day zero, and day 30 of the experiment. On day zero there were no disorders as fruits were still fresh. A total number of six (6) fruits were assessed from each replicate in each of the days. The severity of decay and disorders of the fruits were assessed using a subjective scoring system. The scoring scale was 0 = nil, 1=very slight, 2=slight, 3=medium and 4=high. Values obtained from the score on day 30 of the experiment were transformed to percentages of highest score as using the following equation;

$$\frac{[(N1+N2+N3+N4+N5+N6)]}{(4\times N)} \times 100\%$$

Where N represents the total number of fruit assessed in each replicate and N1, N2, N3, N4, N5 and N6 is the number of fruits affected by the different degrees of decay and physiological disorders during storage period and 4 is constant and represent the highest score of disorders.

Data analysis

The data was subjected to Analysis of variance using Microsoft Excel Data Analysis tool pack 2003 version and significant differences claimed at the 0.05% level. Where significant differences between treatment were detected the location of differences were examined by the least significant difference (LSD) multiple test also conducted at the 0.05% level.

Result and analysis

Weight loss in cantaloupe melon

Melons coated with Natralife™ coating had a signficant effect at 0.05% on weight loss at cold storage of 2°C and 9°C and shelf life room of 20°C and had reduced weight loss compared to uncoated control melons. At day 18 of storage weight loss increased in both uncoated and coated melon held at shelf life room of 20°C reduced to 6.2% and 6.0% respectively (fig. 1). Uncoated melon held under cold storage of 9°C lost 4.5% while coated fruits stored in similar condition lost 4.0% of weight. Uncoated melon stored at cold storage of 2°C lost 2.3% while coated melons held under cold storage of 2°C lost 1.9% of weight.

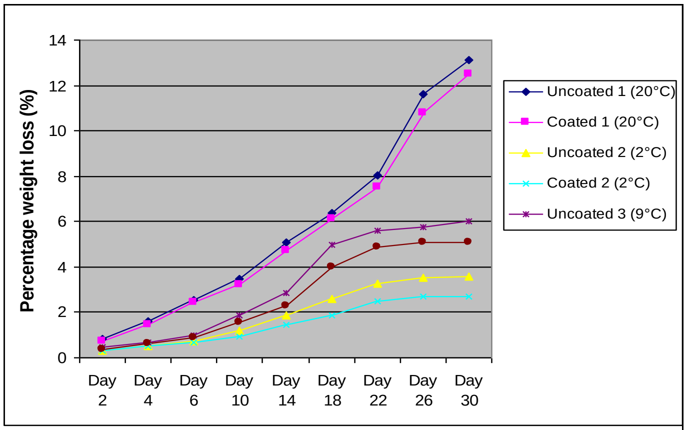

Fig. 1 *weight loss of coated and uncoated cantaloupe melon stored in cold store of 2°C, 9°C and shelf life room of 20°C for 30 days.*

Firmness level in melon fruit

The result showed that fruits stored at shelf life room of 20°C loss firmness at a rapid rate than fruits held at cold store of 2°C and 9°C. At cold store 2°C and 9°C, it was found that both coated and uncoated melons held at 2°C loss less firmness than fruit stored at 9°C cold store as shown in figure .2 below. Melon fruits treated with Natralife^{TM} coating were more firm than control fruit during the storage period at all storage conditions. At day 18 of storage fruit firmness reduced in all treaments with uncoated and coated melon held at shelf life room of 20°C reduced to an average of 86 and 87.1 (Shore). While uncoated and coated melon held under cold storage of 2°C reduced to an average of 89.6 and 90.5 (Shore) respectively. Loss of fruit firmness in uncoated and coated fruits stored at 9°C were 88.4 and 89.2 (Shore) respectively (fig. .2).

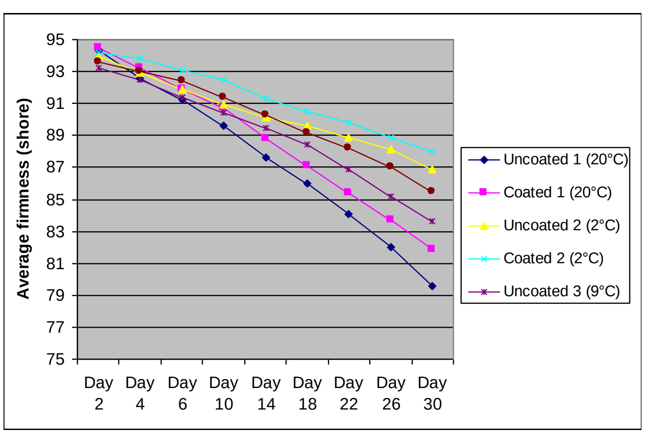

Fig. 2 *Skin firmness of coated and uncoated cantaloupe melon stored at cold store of 2°C and 9°C and a shelf life room of 20°C for 30 days.*

Change in total soluble solid content

Prior to the storage the melons the average total soluble solid (TSS) value was 10.8˚Brix and had been affected by the coatings and temperature during the storage period. There was a gradual decline of TSS in both uncoated and coated melons held at both cold store of 9°C and shelf life of 20°C. After day 15 of storage, the highest total soluble solid content of coated melon fruit was 10.2˚Brix, while the highest total soluble solid content of uncoated fruit was 10.0˚Brix. At day 30 of the storage, the highest TSS of coated was 10.0˚Brix, while the highest TSS recorded by uncoated fruit was 9.6˚Brix compared to the initial average TSS value of 10.8Brix as indicated on Table 1.

Table .1 *Effect of Natralife^{TM} coatings on TSS of Cantaloupe melon stored under shelf life room (20°C), 2°C and 9°C cold storage.*

Storage condition	Treatment	Initial TSS (˚Brix) on day zero	Level of TSS (˚Brix) on day 15	Level of TSS (˚Brix) on day 30
Shelf room (20°C)	Uncoated 1	10.8	7.2	6.9
	Coated 1	10.8	8.6	7.7
Cold store (2°C)	Uncoated 2	10.8	10.0	9.6
	Coated 2	10.8	10.0	10.0
Cold store (9°C)	Uncoated 3	10.8	9.5	8.6
	Coated 3	10.8	10.2	10.0

Diseases or decay and disorders during storage

The result indicated a quite high level of decay in uncoated control melon during the storage period. At cold store of 2°C and 9°C and shelf life of 20°C, the decay and disorders recorded were 16. 7%, 50% and 83.3% while coated fruits stored at shelf life room of 20°C and cold of 2°C and 9°C had 33.3% 0% and 16.7% of the fruit affected respectively (Table 2).The decay severity of fruits was demonstrated by plates 3.1 and 3.2 for uncoated fruits stored at 9°C and 20°C

Plate .1 *Uncoated melon affected by alternaria after 21 days at shelf life room (20°C).*

Table 2 *Effects of Natralife™ coating on the spread of disorders and diseases or decay on cantaloupe melon stored under shelf life room (20°C), 2°C and 9°C cold storage after 30 days of storage*

Storage condition	Treatment	Disorders	Decay or disease	Number of fruits assessed	% of fruits affected
Shelf life (20°C)	Uncoated 1	3	2	6	83.3%
	Coated 1	1	1	6	33.3%
Cold store (2°C)	Uncoated 2	1	0	6	16.7%
	Coated 2	0	0	6	0%
Cold store (9°C)	Uncoated 3	2	1	6	50%
	Coated 3	1	0	6	16.7%

Plate .2 *Uncoated melon showing decay rot after 21 days of cold storage (9°C).*

Discussion

Weight loss in cantaloupe melon

Weight loss of the fruit was affected by the coating treatment and temperature. Weight loss in fruits increased during the storage period in uncoated melons as well as coated melons, however, weight loss was low in coated melon fruits. The highest weight loss of coated and uncoated cantaloupe after 14 days of storage was 4.72%, and 5.07%, respectively, and was found in shelf life room. This indicated that water loss from coated melon was low as compared to uncoated fruit. ,[5] found that cantaloupe melon coated with citruseal citrus wax reduced weight loss after 6 weeks of cold storage at 8°C. The decreased in weight loss of coated melon in this trial could be attributed the effect of the coatings in limiting the amount of water vapour released from fruits into the surrounding because of the good barrier properties of the coatings. Although coated melons stored at cold store of 2°C and 9°C indicated reduced weight loss, however, there was increased in weight loss of melons stored under shelf life room of 20°C. With this a statement could be made that higher temperature during the storage period had influenced the rate of water loss from the fruit. This is because at high temperature in storage there is low relative humidity (RH) which leads to high vapour pressure deficit (VPD), hence increase in water loss which leads to loss of saleable weight of the fruits. The loss of weight could be caused by higher water loss from the fruits to surrounding environment due to low humidity of the ambient. Another possible reason for increased in weight loss of melons held in shelf life room could be the low concentration of the Natralife™ coating leading to rapid transpiration of water from the surface of the fruits stored under high temperature.

Firmness of fruit during storage

The result showed that firmness of fruit decreased with the storage duration and was affected by the coatings and temperature and storage time. Firmness of the fruit decreased during the trial for all treatments and was more noticed in fruit stored in shelf life room of 20°C probably due to water loss. However, coated melon fruit were found slightly firm than uncoated fruit. Previous research work done Honeydew melon coated polyethylene wax stored at 3°C showed retention of fruit skin firmness ,[5].The retention of firmness in this study could be due to the reduction of percentage water loss in fruits. Also it may be as result of decreased respiration as a result of the effect of coating modifying the surrounding round the fruit A closer look at the result of the experiment however suggests that, both coated and uncoated melons stored at 2°C were more firm compared to melons stored under shelf life room of 20°C, and cold storage of 9°C. At cold storage of 2°C and 9°C fruit quality was better as compared with shelf life of 20°C where there was decreased in the firmness of fruit. The result showed that temperature during the storage period could have affected loss of firmness of the fruits through the loss of water. This is because the shelf life room of 20°C could raised the vapour pressure deficit (VPD) to about 23.09 millibars hence increased the rate of water loss in fruit resulting in corresponding increased in loss of firmness compared to fruit at cold storage of 2°C and 9°C. This result is in harmony with,[9] findings, which reported a decreased in firmness of cantaloupe melons held for 3 days at 15°C and 20°C compared to melons stored at 7°C**.** In this experiment, higher temperature during storage of the fruit could have caused the decreased firmness of fruit probably due to decreased turgidity and thinning of cell wall.

Changes in total soluble solid

The result indicated a decreased in TSS throughout the storage period of both coated and uncoated melon fruits. The lowest TSS levels on day 15 and 30 were 7.2 and 6.9˚Brix respectively. Melons fruits ripen while attached to the parent plant, and as such sugar concentration depends on the accumulation of sugars before harvest. After harvest and at the ripe stage the concentration of sugar declines with the onset of senescence,[10]. This was found in melon fruits stored under cold storage and shelf life room in this research work. The decline in total soluble solid content agreed with the finding of [18]. which showed a constant decreased in TSS during storage. In this trial, the constant decreased in total soluble solid of melon fruits stored in cold storage and shelf life room could probably be due to the natural conversion of sugars to substrates as result of increased in storage period. Though, the reduction of total soluble solid was higher at 9°C than fruits stored at 2°C cold storage but lower than those stored in shelf life room. This suggests that at higher temperatures reduction of TSS in fruits occurred and could result to increased respiration of the fruits [4]. Although, there was decreased in TSS of both coated and uncoated control melons in all storage conditions, uncoated melons generally showed a slightly higher reduction in TSS content compared to coated melons, indicating that the coating treatment could slightly retained the total soluble solid content at higher temperature during storage than the uncoated melon fruits.

Diseases and disorders during storage

The result demonstrated a higher level of decay in uncoated control fruits stored in cold store at 9°C and shelf life room of 20°C than coated melon fruit held similar storage. At cold store of 2°C and 9°C and shelf life of 20°C, the decay recorded were 16.7%, 50% and 83.3% respectively. The increase in decay such as alternaria rot was high in both 9°C and 20°C. [16] found alterneria rot and other diseases such as fusarium and mucor rots stored at 8°C in Hami melons. In this study, the cause of decay in melons fruits could be attributed to increased respiration due to increased storage temperature, as more decay occurred in melon fruits held at 9°C and 20°C rather than at 2°C cold storage. Although, other disorders such as yellowing of the rind, flesh softening, were *observed in coated and uncoated melons stored in shelf life room of 20°C and cold stored of 9°C however, more disorders were found on uncoated melon fruit. Yellowing of the rind was noticed more in melons held at 9°C cold storage, however, flesh softening was observed more in melons shelf life room. The increased in rind disorders could be due to increased respiration as storage temperature increased. Chilling injury though suspected to occur at 2°C in the melons did not occur. [18]. reported that Hami melons stored at 2°C cold storage were found to have chilling injury. In this investigation, the result failed to support this finding**.** It therefore found that both coated and uncoated melons fruits can be stored effectively for 30 days at 2°C cold storage, and could mean that at 2°C disorders are better prevented in coated and uncoated cantaloupe melons probably due to low respiration as a result of the low storage temperature.

Conclusion

The result obtained from the Natralife^{TM} coating treatment indicated a reduction in weight loss cantaloupe melons during the storage period. Also, there was retention of fruit skin firmness with Natralife^{TM} coatings in cantaloupe melon fruits. Since there was a reduction of weight loss and retention of fruit firmness with Natralife^{TM} Cantaloupe melon fruits during the storage trial, therefore, the study indicated that Natralife^{TM} coating was effective and had the potential to maintain the postharvest qualities of melon fruits. Therefore, the maintenance of quality and the extension of storage life of Cantaloupe melon fruits through the application of Natralife^{TM} coating demonstrated in this storage trial suggest that the use of Natralife^{TM} coating should be considered for commercial handling and storage of the melon fruits.

Recommendation for further work

Moisture loss in Cantaloupe melon fruits usually affects qualities of fruits after harvest. Any work would be interesting to effect the reduction of moisture and factors which influence it. This is important in the extension of storage life of Cantaloupe melon fruits during postharvest life of the fruits. Natralife^{TM} coating applied on Cantaloupe melons during storage trial have been shown to prolong the storage life of these products. However, for further research work, it is suggested that instead of coating a whole fruit, one part (Hemisphere) of the fruits should be coated to test the effectiveness of the coating on fruits firmness and diseases and other physiological changes between the coated and uncoated part of the fruits. Proper care should be taken in order to use only high quality melon fruits. It is also suggested that in such storage trial, fruit should be coated and stored soon after harvest to avoid physiological stress on fruits before the trial. Any researcher interested in carrying out further work on cantaloupe melon fruits in respect of application of Natralife^{TM} coatings should consider storing the Melon fruits at 2°C. In furtherance to that, it is important to ensure that temperature is stable during such storage trial. For weight loss in melon fruits coated did better compared to those uncoated melon fruits stored under similar conditions. However, it is suggested that increasing the concentration of Natralife^{TM} coating could further enhance water loss reduction in cantaloupe melons. Although the sample size was small, there were low levels of disorders and decay for all temperature conditions with Natralife^{TM} coatings. It is therefore suggested that a large sample size of about 100 fruits should be considered in further research for comparing decay and disorders.

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