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# Effect of Aloe Vera Gel Coating on the Colour Difference of Apricots

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***Abstract***
*Statistical design using RSM, an effective tool for optimization, was used with an attempt to optimize processing parameters i.e. aloe vera, carboxyl methyl cellulose and packaging materials. Experiments were designed using Box Behnken design with three variables. Total 17 experiments were carried out and variable set for all the experiments were coating concentration of aloe vera gel (10%, 15%, and 20%), CMC (0.5%, 0.75%, and 1.0%) and 3 levels of packaging material (40, 80, and 120). The results of the study showedcolour change value E first decreased and then increased with time and was minimum in 11$^{th}$ experiment, 3.998 which has 10% Aloe Vera, 1% CMC. The storage study of apricot samples for 10 days were evaluated on the basis of two way ANOVA and found significant throughout the storage as compared to control. The study revealed that the life increased from 4 days to 10 days in an experiment span of 10 days. The most suitable optimum level was 20%, 0.5% and 80 micros of Aloe-vera, CMC and LDPE.*

***Keywords-*** *aloe vera, carboxy methyl cellulose coating, shelf life of apricots*

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## I. Introduction

Applications of edible coatings is promising to improve the quality and extend shelf life of lightly processed produce (Baldwin, Nisperos-Carriedo, & Baker, 1995; Baldwin, Nisperos-Carriedo, Chen, & Hagenmaier, 1996; Li & Barth, 1998.). Currently the postharvest handling, transportation and marketing of apricot fruit need sophisticated techniques and facilities.Respiratory metabolism can be reduced by reducing the storage temperature. Biological reactions generally increase two or threefold for every 10˚C rise in temperature **(Nicolaï *et al.*, 2009)**. The respiration rate is affected by the development stage and the respiration pattern (climacteric/ non climacteric) of the fruit as well **(Nicolaï *et al*., 2009).**The concept of active packaging is one of the emerging technologies in food packaging. Active packaging refers to the incorporation of certain additives into packaging film or within packaging containers with the aim of maintaining and extending product shelf life **(Day, 1989)**. Different substances that can either absorb or can release a specific gas can control the internal atmosphere within the package. Active packaging system for the fresh fruits includes use of ethylene scrubber, moisture scrubber and $CO_2$ scrubber.

Edible coatings applied on fresh fruits to reduce the moisture transfer, oxidation, metabolic processes, respiration rate, physical/ mechanical impacts and microbial growth and to maintain the sensory quality and safety are important to prolong their shelf life **(Nisperos-Carriedo *et al.*, 1992)**. Edible coating acts as a physical barrier for the gas exchange between the fruit and their storage environment and create modified atmosphere. It slows down both the rates of generating energy and substrate degradation which in turn will slow down the biochemical reactions leading to fruit ripening **(Maftoonazad and Ramaswamy, 2005).**Keeping all above cited issues in mind the present work has been undertaken with the following objectives:

1. To study the effect of different coating materials and packaging materials on quality parameter of apricots during storage in refrigeration condition,.

# II. Materials And Methods

## 2.1 Raw Materials

The present study was conducted at the laboratory of department of Post-Harvest Process and Food Engineering, G.B, Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand.Mature yellow-orange coloured Apricots. The edible coating of aloe vera gel,CMC, HDPE and LDPE packaging materials were procured from local market of Pantnagar, Udham Singh Nagar, and Uttarakhand. Homogeneity in variety of Apricots was maintained.

## 2.2 Experimental Plan and Design

The testing of samples were being done in the department of Post-Harvest Production and Food Engineering, College of Technology, Pantnagar.The fresh yellow-orange apricots were treated with an interaction of CMC and Aloe Vera. All treated samples were stored for 10 days and the samples were observed for changes on $2^{nd}$ day, $4^{th}$ day, $6^{th}$ day, $8^{th}$ day and $10^{th}$day. For the testing purpose, a total of 13 sets of sample replications were being made, each having different coating concentration level. In the testing of samples, following parameteris to be tested.

1. Colour change,

## 2.3 Elementary Testing Phase

Three levels of CMC viz. 0.5%, 0.75% and 1% and three levels of Aloe Vera gel viz. 10% (w/v), 15% (w/v) and 20% (w/v), for both, were taken for the determination of suitable maximum and minimum values of CMC concentration in 500 ml of hot water. Aloe Vera concentration was being varied from 10% (w/v) to 20% (w/v) in the CMC solution being prepared previously. The solution was first allowed to cool and then coating was being applied to the apricots being kept in the sets of two.

The elementary testing phase helped in determining the maximum and minimum level of concentrations which are as follows. The maximum concentration of CMC was found to be 1% (w/v). Above that, the solution became so thick that it inhibited the natural respiration process of apricots. The minimum level of CMC concentration was decided to be 0.5% (w/v), as below this level, the viscosity of the coating was not found to be sufficient enough to hold onto to the apricot samples. Aloe Vera concentrations were found to be good enough at all three levels of 10% (w/v), 15 %( w/v), 20 %( w/v).Hence the weight and concentrations of the materials and packaging materials are shown in **Table 2.1 .**

**Table: 2.1: Different concentrations of coating materials.**

| CMC | Aloe Vera | Packaging material | | | |
|---|---|---|---|---|---|
| 2 grams (0.5% w/v) | 50 grams (10% w/v) | 40 mm | | | |
| 3 grams (0.75% w/v) | 75 grams (15% w/v) | 80 mm | | | |
| 5 grams (1% w/v) | 100 grams (20% w/v) | 120 mm | | | |

**Note: w/v concentration is calculated on the basis of distilled water (500 ml) taken as solvent.**

## 2.4 Determination of colour change

For measurement of colour change images were captured using a high resolution camera. Then, Adobe Photoshop was used to analyse the images and obtain RGB colour parameters of the image, as Adobe Photoshop has the capability to analyse digital images for colour **(Papadakos et. al. 2000)**.

Colour analysis of apricot samples and calculation of colour difference (ΔE), was done using formula

$$\Delta E = \sqrt{(L^* - L)^2 + (a^* - a)^2 + (b^* - b)^2}$$

Where, 'L' is referred to as the lightness or luminance

'a' is defined along the axis of red–green

'b' is defined along the axis of yellow–blue

# III. Results And Discussion

Experiment was conducted on different concentrations of Aloe Vera (10%, 15% & 20%), CMC (0.5%, 0.75% & 1%) and packaging material LDPE at refrigerated storage conditions and qualitative characteristics of coated apricots were determined. **Table 3.1** shows the quality parameter (colour difference) of coated apricots.

**TABLE 3.1: Quality parameters of coated apricots**

| Expt. No. | Coded levels | | | Colour difference |
|---|---|---|---|---|
| | A | B | C | |
| 1 | -1 | -1 | 0 | 5.034 |
| 2 | 1 | 0 | 1 | 4.320 |

| | | | | |
|---|---|---|---|---|
| 3 | 1 | 0 | -1 | 6.129 |
| 4 | 1 | -1 | 0 | 5.242 |
| 5 | 1 | 1 | 0 | 6.312 |
| 6 | -1 | 1 | 0 | 6.224 |
| 7 | -1 | 0 | -1 | 4.528 |
| 8 | -1 | 0 | 1 | 6.129 |
| 9 | 0 | -1 | -1 | 6.129 |
| 10 | 0 | 1 | -1 | 5.132 |
| 11 | 0 | 1 | -1 | 3.998* |
| 12 | 0 | 0 | 0 | 6.129 |
| 13 | 0 | 1 | 1 | 7.890** |
| 14 | 0 | -1 | 1 | 6.042 |
| 15 | 0 | 0 | 0 | 6.129 |
| 16 | 0 | 0 | 0 | 6.099 |
| 17 | 0 | 0 | 0 | 4.548 |

***Minimum value, **Maximum value, A= Aloe vera, B=CMC, C=Packaging material**

### 3.1 Effect of Days and Treatment on Colour difference

Colour is the most obvious indicator of quality of any food material to consumers. It is related to the age of the apricots, handling, and microbial spoilage and that's why colour has been used as an indicator to quantify the shelf life. The colour of fresh apricots is affected by the amount of oxygen presented by the way of suppressing the enzymatic browning reaction. In addition, microbial population could affect the colour changes of fresh apricots. Analysis of variance indicated that the use of the edible coatings and storage variables (temperature and time) in apricots had a significant effect in the colour parameters. L* changes decreased during storage while a sharp reduction is seen for the control. Significant differences were found between the control and treated samples. Apricots with an L* less than 32 would not be acceptable even at retail levels. L* in this experiment ranged from 40 to 47. L* generally decreased over the storage period, indicating a loss of luminosity in the samples over the storage period. Generally, apricots coated with 3.0 grams CMC, and 75 grams aloe vera and level $2^{nd}$ of polyethylene sheet showed the highest L* in all experimental samples during the storage period.

### 3.2Analysis of the Response by ANOVA

The effects of different factors on the experiment were analysed using the Analysis of Variance (ANOVA) by the Design Expert software. This technique is helpful in telling the statistical significance of a factor under consideration by breaking down the total variance of the responses. The significance of a factor is determined by comparing the F-value in the ANOVA table with the tabulated F-value. The technique also helps in determining the significance of lack-of-fit, that diagnose how well each of the full models fit the data. Models with a significant lack-of-fit should not be used for predictions. But since our data set contained replicated set of values for the last four runs, hence lack-of-fit test was not applicable on the model.

### 3.3 Colour Change Analysis

The color change analysis was being done using a high resolution Digital SLR camera (Nikon- D5100) and Adobe Photoshop. The measurement was being done in terms of Hunter L*, a* and b* values. L* represents the lightness or darkness of the sample. Hunter a* represents redness (+) or greenness (-). hunter b* represents yellowness (+) or blueness (-). These values can be calculated as:

$L^* = (L/250) \times 100$

$a^* = (240a/255) - 120$

$b^* = (240b/255) - 120$

These values were used to calculate $\Delta E^*$ for all the samples of Apricots by using following expression:

$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$

Where,

$\Delta L^* = L^* - L_f$

$\Delta a^* = a^* - a_f$

$\Delta b^* = b^* - b_f$

L*, a* and b* are the colour coordinates of the sample and $L_f$, $a_f$ and $b_f$ are the colour coordinates of the fresh sample.

### 3.4 Effect of coating on colour change

The table shows the ANOVA values of the colour change analysis. The F-value of 3.97 suggests that the model is significant and the colour change is greatly affected by the interaction. It also suggests that the probability of this large F-value due to noise is very low i.e. 0.4009% chance. **Table 3.2**shows the results of ANNOVA for colour change.

**Table 3.2: Results of ANNOVA for Colour Change**

| Source | Sum of Squares | $D_f$ | Mean Square | F-Value | p-value Prob > F |
|---|---|---|---|---|---|
| Model | 43.93 | 9 | 4.88 | 3.97 | 0.0414 significant |
| A- Aloe Vera | 4.76 | 1 | 4.76 | 3.86 | 0.0900 |
| B-CMC | 5.61 | 1 | 5.61 | 4.56 | 0.0702 |
| C-LDPE | 0.33 | 1 | 0.33 | 0.27 | 0.6181 |
| AB | 8.61 | 1 | 8.61 | 7.00 | 0.0332 |
| AC | 3.969E-003 | 1 | 3.969E-003 | 3.226E-003 | 0.9563 |
| BC | 16.48 | 1 | 16.48 | 13.40 | 0.0082 |
| $A^2$ | 0.90 | 1 | 0.90 | 0.73 | 0.4218 |
| $B^2$ | 6.38 | 1 | 6.38 | 5.18 | 0.0569 |
| $C^2$ | 0.33 | 1 | 0.33 | 0.27 | 0.6220 |
| Residual | 8.61 | 7 | 1.23 | | |
| Lack of Fit | 4.18 | 3 | 1.39 | 1.26 | 0.4009 not significant |
| Pure Error | 4.43 | 4 | 1.11 | | |
| Cor Total | 52.54 | 16 | | | |

The Model F-value of 3.97 implies the model is significant. There is only a 4.14% chance that an F-value this large could occur due to noise. Values of "Prob> F" less than 0.0500 indicate model terms are significant. In this case AB, BC are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model. The "Lack of Fit F-value" of 1.26 implies the Lack of Fit is not significant relative to the pure error. There is a 40.09% chance that a "Lack of Fit F-value" this large could occur due to noise. Non-significant lack of fit is good **--** we want the model to fit. In this model, AC is a significant model term with a model value of 0.0054. With an Adequate precision ratio of 6.854 this model can be used to navigate the design space. Further analysis gave us the polynomial expression with the coefficients as stated in the following. Also **Table 3.2**shows coefficients calculated for model terms.

**Table 3.2: Coefficients calculated for model terms**

| Factor | Coefficient Estimate | $D_f$ |
|---|---|---|
| Intercept | 5.41 | 1 |
| A- Aloe Vera | -0.77 | 1 |
| B- CMC | -0.84 | 1 |
| C- ldpe | -0.20 | 1 |
| AB | 1.47 | 1 |
| AC | 0.032 | 1 |
| BC | 2.03 | 1 |
| $A^2$ | 0.46 | 1 |
| $B^2$ | 1.23 | 1 |
| $C^2$ | 0.28 | 1 |

The equation is given as;

**Colour change = 5.41 – 0.77*A - 0.84*B – 0.20*C + 1.47*AB + 0.032*AC + 2.03*BC + 0.46*$A^2$ + 1.23*$B^2$ +0.28*$C^2$**

**Where, A= Aloe vera, B=CMC, C=Packaging material**

### 3.6 Compromise Optimization of Responses

Compromise optimization is a process of making compromises among responses to get optimum independent parameters. Numerical optimization was carried out using Design Expert Statistical software. The goal was fixed to be minimum for weight loss, colour difference was kept in range and pH was kept maximum. The goal setup for optimization was given in **Table 3.3.**

**Table 3.3: Optimum levels for ingredients for coating of Apricots**

| Independent variables | Coded levels | Actual levels |
|---|---|---|
| Aloe vera- A | 1 | 20% |
| CMC- B | 0 | 0.5% |
| LDPE- C | 1 | 80 |

## IV. Summary And Conclusion

Colour change value E first decreased and then increased with time and was minimum in 11th experiment, 3.998 which has 10% Aloe Vera, 1% CMC.PH decreased in the time interval due to the loss of organic acids present in apricot.The study revealed that the life increased from 4 days to 10 days in an experiment span of 10 days. The most suitable optimum level was 20%, 0.5% and 80 micros of Aloe-vera, CMC and LDPE.

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