Study of Artificial Ripening of Banana and Mango Using
Histogram Technique

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Abstract: Bananas and mangoes are two widely consumed tropical fruits appreciated for their taste, aroma, and nutritional value. However, both fruits have a relatively short natural ripening period, which poses challenges for growers, distributors, and consumers. To meet the demand for ripe fruits year-round, artificial ripening methods have been developed. This paper provides an overview of the various techniques used to artificially ripen bananas and mangoes, including ethylene gas exposure, calcium carbide treatment, and controlled atmosphere storage. Furthermore, it discusses the physiological changes that occur during the ripening process and evaluates the impact of artificial ripening on fruit quality, safety, and shelf life. Additionally, the paper explores the regulatory frameworks governing the use of artificial ripening agents and the associated health and environmental concerns. Overall, this review aims to deepen understanding of the artificial ripening process for bananas and mangoes and to inform stakeholders about its implications for the fruit industry and consumers.
Keywords: Banana, Mango, Artificial Ripening, Ethylene Gas, Calcium Carbide, Fruit Quality, Regulation, Health Concerns, Environmental Impact

1.Introduction

Food is the essential component which plays a vital role in maintaining a balanced diet in our body. Natural process involved in the ripening of fruits and vegetables takes a long period. Generally ripening means a biological change which involves change in the pigmentation, aroma, and involves in the softening of tissues by breaking the cell wall constituents. Banana and Mango are the most commonly consumed climatic fruit across the world. Firstly, the government or local authorities can help fruit sellers and farmers facilitating convenient transportation and adequate cold storage especially for the seasoned fruits to compensate the transportation and distribution issues in developing countries. Secondly efforts should be made to develop safer and economically feasible guidelines for fruit ripening. Thirdly the consumers should also examine the fruit carefully to select the right fruit bt observing the variation of colour. In order to make them edible to eat, ripening process is done quickly by subjecting them to certain chemicals which makes this process quick, subjection to these chemicals like calcium carbide, arsenic, ethylene helps in reducing the ripening time of the concerned fruits. It takes on average 3-4 days to ripen naturally.

Fruits are widely distributed in nature, commercially important and nutritionally indispensable food commodity. Being a part of a balanced diet, fruits play a vital role in human nutrition by supplying the necessary growth regulating factors essential for maintaining normal health. Whereas explode obesity, diabetes, cardiovascular and cancer diseases are in the majority of the areas in the World, the fruits represent a hope potentially very high to limit the harmful effects of them. Nevertheless, much of way remains to be made for better knowing the impact of the fruits and their components, on the health and the prevention of the principal chronic diseases. Beyond the consumable part of the fruits, an emphasis are also put on the by-products, such as the fruit peels, that could represent precious layers for food, medicinal or cosmetic purposes.
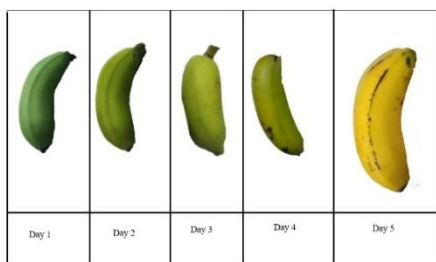
Figure 1.1 Stages of Banana Ripening

This artificially ripening agent breaks the cell wall constituents of the fruit and makes it soft. Though farmers today are provided with various technologies, they still not able to reduce the total number of days consumed for the ripening process. While consumption of such fruits causes various difficulties and injurious to human health but still the vendors sells them to make profit. Consumption of such fruits is completely banned in many countries across the world as they give priority to human health. There are various types of genetically modified plants which play a major role in plant growth, fruit ripening. In such cases there also occurred a condition where the fruits are being exposed to various chemicals over a period which induces the ripening process. There are certain types of fruits which ripen even after harvesting is done and they are named as climacteric fruit. These fruits when ripened, it becomes delicate to transport over long distances. In such cases they are ripened near the place where they are consumed by the people. Such types of fruits are banana, mango, apple, plum, and kiwi. There also occur other types of fruit called non-climacteric fruit which cannot be ripened after getting harvested. Orange, strawberry, grape, grapefruit, raspberry, watermelon are those fruits fall under such category. Moreover certain fruits are used for various purposes like making jam, fresh juice and are also exported. The stage involved in the banana ripening is shown in the Figure 1.1. So in order to retain its freshness they are sprayed or dipped up with chemicals to remain fresh for a longer duration. Though such ways of ripening fruits are avoided by humans, still it is difficult to differentiate the naturally ripened and artificially ripened one. By analysing the pre-defined data sets and their histogram value and threshold value is obtained and with help of android studio an mobile application is developed to identify the mode or the methodology in which the fruit is ripened.

1.1 ARTIFICIAL RIPENING AGENT

Chemicals like calcium carbide, ethylene are used for ripening process these chemicals are commonly called as artificial ripening agents.

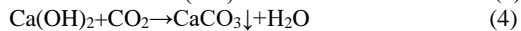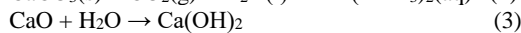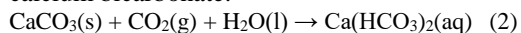### 1.1.1 Role of Ethylene in Ripening

Ethylene is a gaseous component, plays a major role in fruit ripening process. Ethylene has great influence in breaking the cell wall constituent and makes the ripening faster. This ethylene hormone in plant induces respiration, autocatalytic ethylene production and change in colour, aroma, flavour and texture. Almost all climatic fruits have effect for ethylene subjection. Generally ethylene is a colourless gas, which has a pleasantly sweet smell. It is very reactive and flammable. Ethylene belongs to a group of substances called volatile organic compounds (VOCs). Consumption of ethylene is not harmful to human health. Most of the cases bananas, tomatoes were being taken off from the plant in an unripen state to facilitate easy transportation and then are exposed to this gas to ease the ripening process.

1.1.2 Role of Calcium Carbide

Calcium carbide is the most commonly used artificial ripening agent. It is used in most of the countries. Carbide when come in contact with atmospheric pressure, it produces acetylene which is more similar to ethylene which induces ripening process. Calcium carbide is a dangerous and toxic chemical fruits and ripening using such chemical has certain harmful effects in our human body. Exposure of calcium carbide to the moisture produces acetylene gas that affects neurological system. It also causes health hazard, dizziness, memory loss, sleepiness, mental confusion.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g) \qquad (1)$$
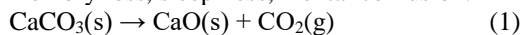
Calcium carbonate when reacts with water, saturates with carbon dioxide to form the soluble calcium bicarbonate.

$$CaCO_3(s) + CO_2(g) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq) \quad (2)$$
$$CaO + H_2O \rightarrow Ca(OH)_2 \qquad (3)$$
$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3\downarrow + H_2O \qquad (4)$$

Calcium carbide treatment of food is extremely hazardous because it contains traces of heavy metal, arsenic and phosphorus. Calcium carbide causes various health hazards like, headache, dizziness, mood disturbances, sleepiness, mental confusion, memory loss, cerebral edema and seizures
.

1.1.3 IMPACT OF ARTIFICIALLY RIPEN FRUITS

The fruits which are ripened with help of artificial ripening agents like ethylene, arsenic, calcium carbide lack the aroma and flavour present in it. The ethylene which is a growth hormone present in plants some time causes death of the plant. Consumption of this chemical also causes various health hazards in humans.

In [7] , Food and health departments in various countries had stopped the usage of these chemicals in considering the health of citizens. But in India

there are no such restrictions prevailing. These chemicals have various harmful impacts on human health. Consumption of these fruits may cause vomiting, alkaline contain may even cause stomach ache throat sores, cough and shortness of breath and so on. The chemical calcium carbonate is a carcinogen which apart from this also causes weakness in hand and legs it may even led to memory loss in peoples. They also cause peptic ulcers which are consumed over a prolonged period.

As the consumption of such fruits are injurious to health and cause various issues this type of fruit should be avoided consumption. Though they are not banned by the government our seller used to use them in business motto. So the people should be given proper awareness about their negative aspects of consuming. This application helps to find whether the captured fruit is naturally ripped or by artificial means. By considering certain parameters like getting up the histogram values by processing the image and by analysing it we can predict whether the given fruit is ripened by the natural means or artificial means. There were various parameters which we considered like the colour of the fruit after this, the above discussed method for carried on finding the way of ripening.

2.1 EXISTING METHODS
2.1.1 FLOAT TEST

Figure 2.1 Float test

The fruit is dropped into a bowl of water as shown in the Figure 2.1, where the naturally ripen one sink to the bottom whereas the artificial one will float as its immature.

2.1.2 APPEARANCE TEST

- Appearance and taste
- Naturally ripened bananas have black or brown stalk and have a sweet taste. The skin of it appears dark yellow with black and brown spots spread unevenly all over
- Artificially ripened bananas on the other hand, appear immaculate with lemon yellow skin with big black spots in the later stages. They also have a green stalk in the early stages. Artificially ripened bananas have traces of powdery substances and peel off quickly. They taste bland. They even have a shorter shelf-life
- When it is artificially ripened that conversion of starch to sugar is not complete and as a result, the taste is not sweet. You wouldn't get the natural fruit taste.

2.1.3 CHEMICAL TEST

- This involves a solution called sensor solution which is a bio-functionalised gold nanoparticle.
- Wash the test fruit with 10ml of water and take 1ml of the wash and mix with equal volume of sensor solution in a glass test tube and mix
- The Colour change of solution from red to purple indicated the presence of calcium carbide.
- If no colour change is observed, then the fruit is naturally ripened.

2.1.4 Limitation of Existing Methods

- This method requires expect people to find the difference among the fruits
- This method doesn't give100% results
- This is a time-consuming process
- Not known to many

3.PROPOSED METHOD

Initially varieties of mangoes and bananas where taken and made to ripen in both natural and artificial means. Based on the analysis of the pictures taken a threshold value was obtained by the study of histogram and then this was dumped in the Jetson Nano board to see the accuracy level. The accuracy obtained was satisfactory and the same algorithm is implemented for another variety of fruit and a mobile application was developed in android studio using AWS lambda and the desired output is obtained.

3.2 PROCESS OF CLASSIFICATION

The histogram of the naturally ripened fruits is processed and threshold values for some tones are determined and when a new image is obtained from the user, it gets processed. The values of the histogram are compared with the threshold values. If the values of the image to be identified are greater than the already available threshold values, then the fruit in the image will be an artificially ripened fruit. If the values of the image to be identified are less than the already determined threshold values, then the fruit is naturally ripened well
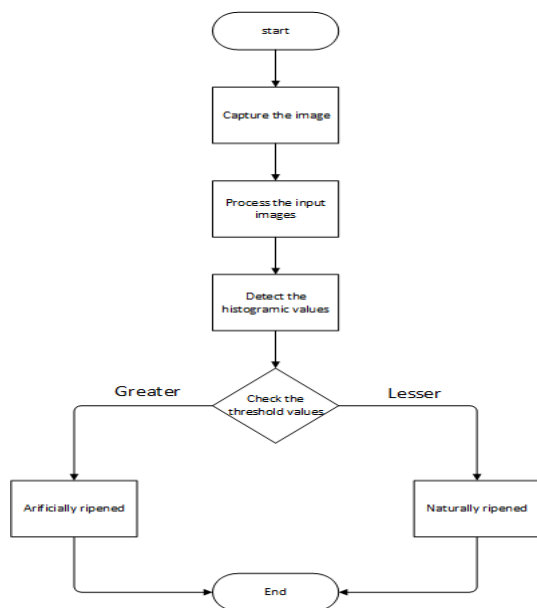
The proposed work helps us to identify the way in which the banana and mango are ripened. For the purpose of examination few varieties of bananas and mangoes were collected and subjected to normal surroundings among which few bananas were allowed to ripen in natural mean and some other were subjected to artificial ripening agents like calcium carbide and ethylene which induces early ripening of the fruit and such ripened fruit were called as artificially ripened fruits. The fruits ripened by either way shown in Figure 3.1 and 3.2 were given as sample inputs to the mobile application for further process.

Figure 3.1 Banana   **Figure 3.2 Mango**

3.3   HISTOGRAM

The captured artificially ripened fruit image is given as input to Jetson Nano. The python program along with open CV in the processor reads the input image file. The histogram of an image is the graphical representation of the tonal distribution. It plots a graph of the total number of pixels present for a total value of the image. This histogram can be used to understand the image's tonal distribution at a quick look. The digital camera nowadays has the feature of viewing the histogram of the image captured by the camera. In reference to [16], This histogram image is useful for detection of images due to its dynamic way of estimating raw pictures. The histogram of an image can be read as when the image is darker the left side of the histogram gets a

huge spike and the graph moves to the left which indicates the darkness in the image. If the image is overexposed the right side of the histogram graph gets a huge spike and the graph moves to the right side. These spikes at the edge of the histogram graph also indicate that the details of the image are also lost while taking the image. The details of the image are mostly present at the centre of the graph. The details can be used to detect whether the fruit was ripened artificially or naturally.

3.4 MASKING

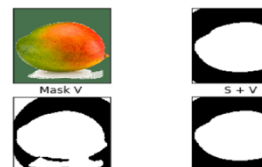

Figure 3.3 Masking of Banana   Figure 3.4 Masking of Mango

After completion of the all process this is how the masked image of the fruits looks like as shown in the figure 3.4 and figure 3.4.

3.5 RGB Image

RGB is one of the formats of colour images. Here the input image is represented with three matrices of sizes regarding the image format. The three matrices in each image correspond to the colours red, green and blue and says that of how much of each of these colours a certain pixel should use.

3.6 HSV Image

he HSV (which stands for Hue Saturation Value) scale provides a numerical readout of your image that corresponds to the colour names contained therein. Hue is measured in degrees from 0 to 360.

3.7.3 Binary Image

A Binary Image is a digital image which has two assigned pixel values. Typically, the two colours used for a binary image are black and white. The gray image of Fruits is converted to binary image this means that each pixel is stored as a single bit (0 or 1). Binary images used in digital image processing as masks or as the result of some frequent operations such as segmentation, thresholding, and dithering.
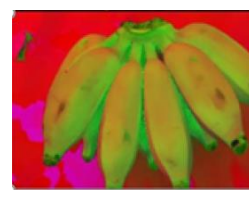
Figure 3.7 RGB Image   Figure 3.8 HSVimage

Figure 3.9 Binary Image   Figure 3.10 Background Subtraction

3.7.4 Filtering

The purpose of filtering is to smooth the image. This is done to reduce noise and improve the visual quality of the image. Often, smoothing is referred to as filtering. Here filtering is carried out by median filter since it is very useful in detecting edges.

3.7.5 Background Subtraction

Background subtraction is a process of extracting foreground objects in a scene of an image. A foreground object is defined as an object of attention which helps in reducing the amount of data to be processed.

After completing the process, the histogram value of image is obtained and the graph is plotted after completing certain mathematical operation the threshold value is obtained. If the value of histogram lies within the threshold value it is said to be naturally ripened else, it is termed as artificially ripened fruit.

4.RESULTS AND DISCUSSION

Few bananas of variety thenuvalai, and poovalai and in mangos of varieties of Nadusalai and Malkovva were collected and kept for analysis purposes. Among them few were said to ripen in natural means and the other were done by artificial means using calcium carbide. Continuously monitored and the pictures were captured under the same surroundings. Then the picture was masked up and done further analysis to acquire their histogram value. The value was obtained and shown in the table 4.1.
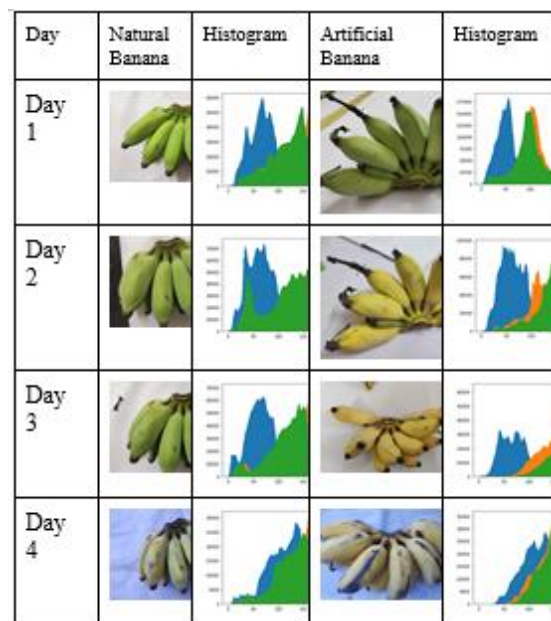

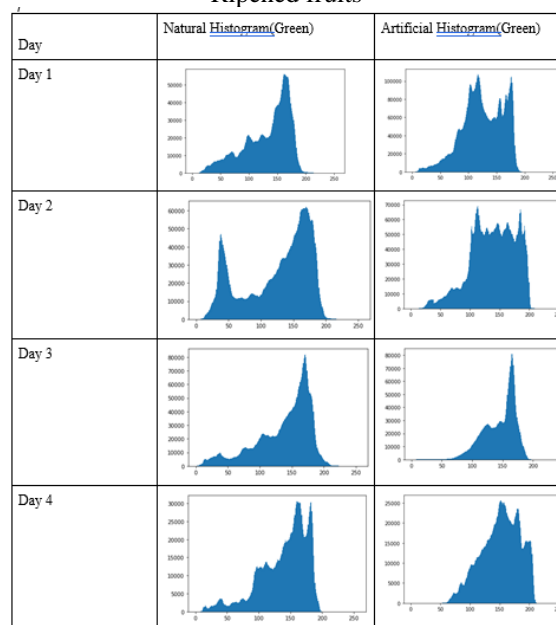Table 4.1 Histogram of Natural and Artificially Ripened fruits

Table 4.2 Histogram of Green colour

The amount of yellow, green colours present in the fruit is obtained from the masked image of the fruit. If the amount of each colour is used to compare with the threshold value to categorised the fruit as naturally ripened fruit or artificially ripened fruit. By manipulating this with help of a formula a graph is plotted and that's shown in Table 4.3 The efficiency for variety -1 (Thenvalai) is about 94.75%.

Days	No of inputs taken for test		Known counts				Obtained ouput			
			Natural		Artificial		Natural		Artificial	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
Days 1	50	50	30	30	20	20	33	32	17	18
Days 2	50	50	25	25	25	25	28	28	22	22
Days 3	50	50	25	25	25	25	23	24	27	26
Days 4	50	50	28	22	22	28	24	18	26	32

Table 4.3 Efficiency Table of Banana

Among the varieties of bananas analysed on the day 1 we approximately get an average of 91.5 percent samples correct because on that particular day the bananas are not ripen and almost in green colour so its hard to find the difference. Whereas on the day 2 and day 3 the banana will be edible and ready to eat so finding the difference is easy to find and also we get an maximum efficiency on that day of 96.5 percent. In same manner while predicting the output on the day 4 the bananas will be over ripe and not edible so in such case also there occurs a difficulty in finding the correct method of ripening.

Days	No of inputs taken for test		Known counts				Obtained ouput			
			Natural		Artificial		Natural		Artificial	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
Days 1	30	30	15	15	15	15	18	12	18	12
Days 2	30	30	15	15	15	15	14	16	13	17
Days 3	30	30	15	15	15	15	14	16	16	14
Days 4	30	30	15	15	15	15	17	13	17	13

Table 4.4 Efficiency Table of Mango

Among the varieties of Mango V1-Nadusalai V2-Malkova as analysed on the table 4.4, day 1 we approximately get an average of 90 percent samples correct because on that particular day the bananas are not ripen and almost in green colour so its hard to find the difference. Whereas on the day 2 and day 3 the mangoes will be edible and ready to eat so finding the difference is easy to find and also we get an maximum efficiency on that day of 96.5 percent. In same manner while predicting the output on the day 4 the mango will be over ripe and not edible so in such case also there occurs a difficulty in finding the correct method of ripening.

On average in our project we get an overall efficiency of correct prediction is about 94%.

4.1 OUTPUT

Figure 4.1 Result for Naturally ripened Banana

Figure 4.2 Result for Artificially ripened Banana

When the image of the banana or mango are given as input to the mobile application, the image is analysed, and the desired output is obtained as shown in the figure 4.1, 4.2 The is normalized, filtered, the background is subtracted, and the histogram is obtained. In [16], Based on the threshold value the image is characterised as Artificial or Naturally ripened fruit.

5.CONCLUSION

As the consuming of artificially ripened fruits are hazardous to human and causes various discomfort to human health it's important to find a methodology to identify them. The proposed method states that by saying fruits which are ripened using chemicals like calcium carbide, ethylene by artificial agents to make the ripening occur at short time and ready for selling. Thus, there occurs a need to find those fruits. Following the algorithm described in this work, it can be implemented in OpenCV by obtaining the histogram value and finding a threshold of the banana and mango which helped to differentiate among the natural and artificial one.

The image of the fruit is being captured and fed into Jetson Nano board coded with the algorithm to find them, if the picture is found and if it falls under such threshold range, we can predict that the captured image of the fruit is ripened by artificial or natural. As this method helps to find the method by which the fruit is ripened by the mobile click this motivates people to consume healthy fruits which is not hazardous to their health, and also can avoid the artificially ripened one which is injurious to our health. The proposed method has an efficiency of 94.75%.

6. FUTURE WORK

The proposed work is now capable of recognising the banana and the mango ripened either by artificial or natural means and this algorithm can further developed to find other fruits also. By incorporating artificial intelligence (IOT), machine learning algorithms we can also find the same in a larger perspective and with greater accuracy. The threshold calculation for other fruits should be varied to obtain the desired output for that fruit.

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