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Comparative Study on the Ripening Ability of Artificial Ripening Agent (Calcium Carbide) and Natural Ripening Agents

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ABSTRACT

Commercial ripening has become an important aspect fruit industry. People consume fruits, ripened with hazardous chemicals like calcium carbide which pose great health risks to the population. Therefore, the present study was designed to compare natural ripening agents (apple, pear, tomato) with artificial ripening agent (calcium carbide) for ripening of banana. Different Batches of banana were made with natural ripening agents & calcium carbide (1gm and 2 gm). The ripening ability was assessed by keeping the batches in two different storage conditions i.e. paper bag & plastic container. Sensory evaluation was done both by Hedonic scoring. The data revealed that bananas kept in plastic container ripened before those placed in paper bags and were more acceptable. Moreover, bananas placed in containers with apples took only 4 days to ripen whereas those placed with calcium carbide at both concentrations took 5 days. The study concluded that natural ripening agents especially Apple are better as compared to artificial ripener . Also, they are devoid of any potential health risks for the adolescents & adults.

Keywords : *Artificial ripening, calcium carbide, natural ripening agents, banana*

INTRODUCTION

The South Asian countries like India, Pakistan, Bangladesh, Nepal, Sri Lanka, Bhutan and the Maldives have a wide range of climatic conditions with the altitude and agro-ecology suited for a wide diversity of tropical fruits.The major fruits grown in these countries are banana, mango, citrus, pineapple and papaya. Besides these, a large number of minor fruits are also grown in the region such as black berry, tamarind etc. In recent times there is much concern about artificial ripening of fruits in many parts of the world[1].

RIPENING

Ripening is the final stage of development of a fruit which involves series of physiological and biochemical events leading to changes in colour, flavour, aroma and texture that make the fruits both attractive and tasty. During ripening, the starch in the fruit breaks down to sugar. The fruit skin color changes green to bright red or yellow. These changes attract birds, animals and consumers. The ripening of a fruit depends on the season[2].Fruit ripening is a highly controlled and programmed developmental event, involving the co-ordination of a multitude of metabolic changes and involves the activation and inactivation of various genes leading to biochemical and physiological changes within the tissue[3-6]. Fruits may be classified as climacteric or non-climacteric depending on its respiration rate. Climacteric fruits are characterized by transient increase in both ethylene synthesis and respiration at an early stage of ripening. The peak of ethylene production rate is proportional to the peak respiration rate. Fruit softening, color changes, development of taste and flavour and a number of other parameters of ripening process are associated with the climacteric cycle. The climacteric fruits are avocado, banana, cherimoya, mango, kiwifruits, apple, apricot, cucurbit, jackfruit, papaya, peach, pear, plum and tomato. Non- climacteric fruit does not show any increase in respiration and ethylene synthesis during ripening. In fact, non-climacteric fruits show decline in their respiration rate and ethylene production throughout the ripening process. Non-climacteric fruits are citrus fruits, cherry, cucumber, grape, lemon, orange, pepper, pineapple, strawberry, etc[7].

ARTIFICIAL RIPENING

Various artificial methods of fruit ripening have been observed mostly to meet consumers' demand and other economic factors. People consume fruits, ripened with hazardous chemicals like calcium carbide. These pose great health risks to consumers[8]. Fruit sellers artificially ripen green fruits even during the due season to meet the high demand and make high profit of seasonal fruits. Transporting and distributing fruits from the farmers' orchards to consumers' baskets can take several days. During this time the naturally ripened fruits may become over ripen and inedible. A part of naturally ripened fruits can also be damaged during harsh condition of transportation. It indeed increase great economic loss for the fruit sellers and therefore, to minimize the loss, fruit sellers sometimes prefer collecting fruits before full maturity and artificially ripen fruits before selling to the consumers[9]

CHEMICALS USED IN FRUITS

Fruits are highly nutritious and form an important food item in the human diet. On the other hand these are highly perishable due to their short shelf life. These food commodities are contaminated with toxic and health hazardous chemicals like calcium carbide, ethylene which are being used for ripening fruits and protecting them from rottening and damage. Moreover, formalin and some other chemicals are also used for extending the shelf life of fruits which are reported to cause several health problems like such as dizziness, weakness, ulcer, heart disease, skin disease, lung failure, kidney failure and cancer etc. The widespread use of formalin and other chemicals for preservation of fruits has become a great concern among the people. The chemicals used as spray solution make fruits attractive[10].

CALCIUM CARBIDE

Calcium carbide (available as grayish black powder) is commercially intended for welding purpose but its use in the artificial ripening of climacteric fruits is rampant in many developing countries. Calcium carbide, once dissolved in water, produces acetylene which acts as an artificial ripening agent[23].Fruits ripened with calcium carbide are soft and have good peel colour development but are poor in flavour. Calcium carbide, popularly known as masala, is used extensively in mangoes, bananas and papayas and sometimes in apples and plums. Being cheap (one kg of this chemical costs Rs. 25-30, which can ripen 20 tonnes of fruit), it is indiscriminately used by the traders in preference to other recommended practices of inducing ripening like dipping fruits in a solution of ethephon, or exposure of fruits to ethylene gas[11].

However, treatment of fruits with calcium carbide is extremely hazardous because the chemical is known to contain traces of arsenic and phosphorous. Acetylene gas produced by calcium carbide may affect the neurological system by inducing prolonged hypoxia gradually culminating to headache, dizziness, mood disturbances, sleepiness, mental confusion, memory loss, cerebral edema and seizures[11].

As per the rule 44 AA of the Prevention of Food Adulteration Rules 1955 "*No person shall sell or offer or expose for sale or have in his premises for the purpose of sale under any description, fruits which have been artificially ripened by use of acetylene gas, commonly known as carbide gas*." In spite of such a restriction, calcium carbide is often utilized as a ripening agent in commercial front[12].

METHODOLOGY

The study was divided into 4 phases. Phase I includes procurement & selection of fruits. The unripe fruits i.e. banana were procured from the local market of Dabua colony, Faridabad. Unripe banana with uniform peel colour and size were selected. Ripe bananas were excluded. Natural ripening agents i.e. apple, pear and tomato were procured from the local market of Dabua colony, Faridabad. The fruits were selected on the basis of ethylene production. Unripe fruits were not included as ripening agents. Also bruised fruits were not used in the experiment. Calcium carbide was procured by the local chemical vendor from N.I.T 5 local market, Faridabad. The phase II involved experimentation & observation. Six bunches of unripe banana were labelled as A,B,C,D,E,F containing 5 bananas each were exposed to similar environmental conditions. These batches were exposed to two different storage conditions i.e. plastic container & paper bag. These were exposed to varying amounts & types of ripening agents. Thus while batch A was allowed to ripen naturally, batch B & C were exposed to 1gram & 2gram calcium carbide respectively. Batch D was exposed to single apple while batch E & F were exposed to single tomato & pear respectively (Table 1). Change in the skin-color from green to yellow was considered as the stage for the ripening of fruit. Phase III includes, subjective evaluation, which was done to assess the ripening ability of different batches. Hedonic scoring methods were used in the sensory evaluation of bananas. For sensory evaluation precautions were taken as recommended by FSSAI, the banana was pealed and then sensory evaluation was done. Objective evaluation was also done by assessing the titrable acidity and performing benedicts test. Phase IV includes statistical analysis, SPSS version 20 was used to assess mean, standard deviation and ANOVA

Precaution – Fruits were wash thoroughly with water before sensory evaluation.

Table 1: Formulation of batches for experiment

Batches	Banana	Artificial ripening agent	Natural Ripening Agent
Batch A1	5 Unripe Banana	-	-
Batch B1	5 Unripe Banana	1 gram calcium carbide	-
Batch C1	5 Unripe Banana	2 gram calcium carbide	-
Batch D1	5 Unripe Banana	-	1 Apple
Batch E1	5 Unripe Banana	-	1 Pear
Batch F1	5 Unripe Banana	-	1 Tomato

RESULTS AND DISCUSSION

It was observed that the batches stored in plastic container differ in the ripening ability. The banana stored in batch A took 10 days to ripen while batch B & C took 5 days respectively. Batch D took 4 days while E & F took 7 & 9 days repectively. Those batches stored in paper bags took 10 days to ripen. Ripening was similar in all the batches of paper bag storage (Figure 1).

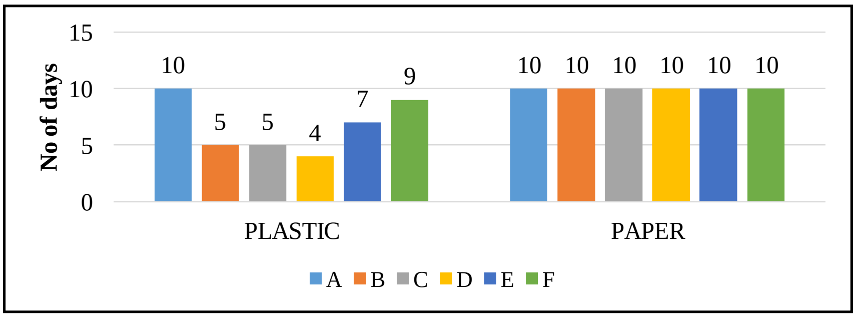

Figure 1. Duration taken by different ripening agents for ripening of banana

BATCHES: A) Control B) Unripe fruit + 1 gram calcium carbide C) Unripe fruit + 2 gram calcium carbide D) Unripe fruit + Apple E) Unripe fruit + Pear F) Unripe fruit + Tomato

Sensory evaluation revealed (Table 1) that bananas stored with apple (batch D) were the most acceptable in plastic container storage. However no significant differences were observed in the different batches stored in paper bag storage. Hedonic scoring was done to collect the data.

Table 2. Mean acceptability score of attributes between the batches: composite scoring (container storage)

Parameters	A	B	C	D	E	F	F-value	P-value (ANOVA)
Appearance*	1.7±7.78	2.8±0.42	3.0±0.00	4.20±0.42	1.80±0.63	3.10±1.10	2.296	0.049
Skin-colour*	2.4±7.66	2.40±0.96	3.2±1.03	4.30±0.67	1.40±0.96	2.60±1.17	2.436	0.045
Aroma	2.4±6.99	3.50±1.17	3.4±1.17	4.30±0.82	2.20±1.13	3.80±1.31	2.197	0.067
Firmness*	1.6±7.57	2.40±0.69	3.0±0.66	3.8±1.03	1.40±0.84	2.90±0.73	2.407	0.047
Taste*	1.2±2.86	2.80±0.78	3.20±0.91	4.40±0.69	1.50±0.84	2.80±1.03	2.157	0.041
Mouth-feel*	1.4±7.94	2.50±0.84	3.40±0.84	4.40±0.51	1.60±0.69	3.00±0.94	3.557	0.007
Overall Acceptability*	1.3±7.06	2.80±0.63	3.00±0.81	4.30±0.48	1.60±0.69	3.00±0.93	1.925	0.008

*significance = Level a+P< 0.05

BATCHES: A) Control B) Unripe fruit + 1 gram calcium carbide C) Unripe fruit + 2 gram calcium carbide D) Unripe fruit + Apple E) Unripe fruit + Pear F) Unripe fruit + Tomato

Table 2 shows the mean acceptability score of attributes between the batches. In appearance, there was a statistically significant difference (P<0.05) between the batches as determined by one-way ANOVA. Batch D had the highest mean value i.e. 4.20±0.42 whereas batch A had lowest mean value i.e. 1.7±7.78. Thus batch D was most acceptable.

Batch D had the highest mean value for skin-color i.e. 4.30±0.67 whereas Batch E had lowest value (1.40±0.96). Thus batch D was most acceptable & the differences were statistically significant (P<0.05) among batches.

Regarding aroma, highest mean value was for batch D & lowest for batch E. Thus batch D was most acceptable. However, the difference were not statistically significant (P=0.067).

Batch D had the highest mean value for firmness i.e. 3.8±1.03 whereas Batch E had lowest value1.40±0.84. Thus batch D was most acceptable & the difference were statistically significant (P<0.05) among batches.

For taste, batch D had highest mean value i.e. 4.40±0.69 whereas batch A had lowest value i.e. 1.2±2.86. Thus batch D was most acceptable & the differences were statistically significant (P<0.05) among groups.

For mouth-feel, batch D had highest mean value i.e. 4.40±0.51 whereas batch A had lowest value i.e. 1.4±7.94. Thus batch D was most acceptable. The differences were statistically significant (P<0.05) among groups.

The overall acceptability was highest for batch D with mean value of 4.30±0.48, however it was lowest for batch A. Thus batch D was most acceptable & the differences were however statistically significant (P<0.05).

Batch D was most acceptable regarding all the attributes regarding all the attributes except aroma and the overall acceptability was also higher for batch D as compared to other batches.

Table 3. Mean acceptability score of attributes between the batches: composite scoring (ANOVA-TEST)

Parameters	A	B	C	D	E	F	F-value	P-value (ANOVA)
Appearance	2.9±0.73	2.3±0.94	2.9±0.73	2.9±1.10	3±1.15	2.9±0.87	0.743	0.594
Skin-colour	2.9±0.73	2.8±1.31	3±1.24	3.1±0.87	3±0.66	2.9±0.56	0.123	0.987
Aroma	3.1±0.87	2.8±0.78	3.1±0.73	2.8±0.78	3.1±0.99	2.9±0.87	0.315	0.902
Firmness	3±0.81	2.9±0.73	2.7±0.94	3.4±0.69	3±1.05	3±0.81	0.713	0.617
Taste	2.4±0.96	2.6±1.07	2.9±0.56	3.2±0.78	3.2±0.42	2.9±0.87	1.549	0.19
Mouth-feel	2.9±0.73	2.9±0.99	2.7±0.82	2.9±0.99	3.2±0.91	2.8±1.13	0.315	0.902
Overall Acceptability	3.2±0.63	2.6±0.84	3.4±0.69	3.1±0.87	3.3±0.67	2.9±0.56	1.635	0.197

*significance = Level a+P< 0.05

BATCHES: A) Control B) Unripe fruit + 1 gram calcium carbide C) Unripe fruit + 2 gram calcium carbide D) Unripe fruit + Apple E) Unripe fruit + Pear F) Unripe fruit + Tomato

Table 3 shows the mean acceptability score of attributes between the batches. With regard to appearance, there was not a statistically significant difference between the batches as determined by one-way ANOVA. Batch E had the highest mean value i.e. 3±1.15 whereas batch B had lowest mean value i.e. 2.3±0.94.

Batch D had the highest mean value for skin-color i.e. 3.1±0.87 whereas Batch B had lowest value 2.8±1.31 but the differences were statistically not significant among batches (P=0.987).

The aroma had highest mean value for batch E i.e. 3.1±0.99 & lowest for batch B & D but the differences were statistically not significant among batches (P=0.902).

Batch D had the highest mean value for firmness i.e. 3.4±0.69 whereas Batch C had lowest value i.e. 2.7±0.94 but the differences were statistically not significant (P=0.617).

For taste, batch D & E had highest mean value whereas batch A had lowest value i.e. 2.4±0.96. Thus batch D & E were most acceptable. The differences were however, statistically not significant among batches (P=0.190).

For mouth-feel, batch E had highest mean value i.e. 3.2±0.91 whereas batch A had lowest value i.e. 2.7±0.82 but the differences were statistically not significant among batches (P=0.902).

The overall acceptability was highest for batch E with mean value of 3.3±0.67, however it was lowest for batch B but the differences were statistically not significant among batches (P=0.197).

Sensory evaluation revealed (Table1) that bananas stored with apple (batch D) were the most acceptable in plastic container storage. However, no significant differences were observed in the different batches stored in paper bag storage.

Objective evaluation

A) TITRABLE ACIDITY

Table 4. Titrable acidity for different batches

Batches	A	B	C	D	E	F
BANANA-PLASTIC STORAGE	0.1	0.107	0.154	0.16	0.107	0.127
BANANA-PAPER BAG STORAGE	0.1	0.106	0.111	0.114	0.117	0.114

BATCHES: A) Control B) Unripe fruit + 1 gram calcium carbide C) Unripe fruit + 2 gram calcium carbide D) Unripe fruit + Apple E) Unripe fruit + Pear F) Unripe fruit + Tomato

Table 4 showed the titrable acidity of different batches under different storage conditions. In banana-plastic storage batch D i.e. 0.16 had the highest titrable acidity while batch A had the lowest acidity i.e. 0.1.

In banana-paper bag storage, Batch E had the highest titrable acidity i.e. 0.117 while batch A had the lowest titrable acidity i.e. 0.1.

BENEDICT'S TEST

Table 5. Benedict's test for banana – plastic storage

BANANA-PLASTIC STORAGE	COLOUR
Batches	Colour
A	Green
B	Red
C	Dark Red
D	Dark Red
E	Green
F	Red

BATCHES: A) Control B) Unripe fruit + 1 gram calcium carbide C) Unripe fruit + 2 gram calcium carbide D) Unripe fruit + Apple E) Unripe fruit + Pear F) Unripe fruit + Tomato

Table 5 showed that the benedicts test gives dark red colour in both Batches C & D that means these have the highest content of reducing sugars and thus are ripened.

Batches A& E showed green colour with benedicts test which means that these are low in reducing sugars & thus are unripe.

Batches B & F show red colour with benedicts reagent which means these have moderate reducing sugar content and thus are partially ripe.

Thus batches C & D were most acceptable as they were fully ripened.

Table 6. Benedict's test for banana – paper bag storage

BANANA-PAPERBAG STORAGE	Colours
Batches	Colour
A	Dark red
B	Dark red
C	Dark red
D	Dark red
E	Dark red
F	Dark red

BATCHES: A) Control B) Unripe fruit + 1 gram calcium carbide C) Unripe fruit + 2 gram calcium carbide D) Unripe fruit + Apple E) Unripe fruit + Pear F) Unripe fruit + Tomato

Table 6 showed that the colour of all the batches is somewhat similar which shows that all the batches contain reducing sugars and thus are ripe.

CONCLUSION

The present study indicates that apple can be used as a ripening agent for banana as it can reduce the ripening time. Apple ripened the banana 1 day before calcium carbide so it can be considered as an effective ripening agent as compared to the other natural & artificial ripening agents. Use of apple as a ripening agent for banana can eliminate the potential health risks caused by the use of calcium carbide. Also it was observed that plastic storage was better as compared to paper bag storage as paper is gas permeable.

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