Article ID 4240215

Ripening And Its Control Using Active Packaging and Monitoring Using Intelligent Packaging

[1]Nitika Bishwas, [1]Ayush Gupta, [1]Tangringchi S Momin, [1]Chilse C Marak, [1]T. Siponglemla, [1]Sasikumar R. *, [1]I. B. Mangang*

[1]Department of Agri-Business Management and Food Technology, North Eastern Hill University (NEHU)- Tura Campus, Meghalaya

*Corresponding Author: 12barunmangang@gmail.com

Ripening is a vital stage for any fruit and vegetable production. This stage holds all the economic value for any commercial fruits. So basically, ripening is the process of fruit gaining their desirable colour, taste, texture, and quality. Physiologically and biochemically, it is the process of starch converting into sugar which basically gives the taste of the fruit. Consequently, the breakdown of chlorophyll along with the accumulation of other enzymes is responsible for red, yellow, orange and other colours, gives colour to the ripened fruits and so the breakdown of fruit's cell wall gives its texture i.e., firmness of the fruit. On the basis of ripening, there are two types of fruits which is explained further (Saltveit, 2005).

Climacteric fruits

Those fruits can ripe properly even if they are separated from their parent plant and if they are harvested at the completion of their growth period. For example, Mango, Apple, Banana and Avocado.

Non – climacteric fruits

Those fruits can ripe properly only if they are attached to their parent plant. For example, Strawberry, Blueberry, Cherry and Grapes.

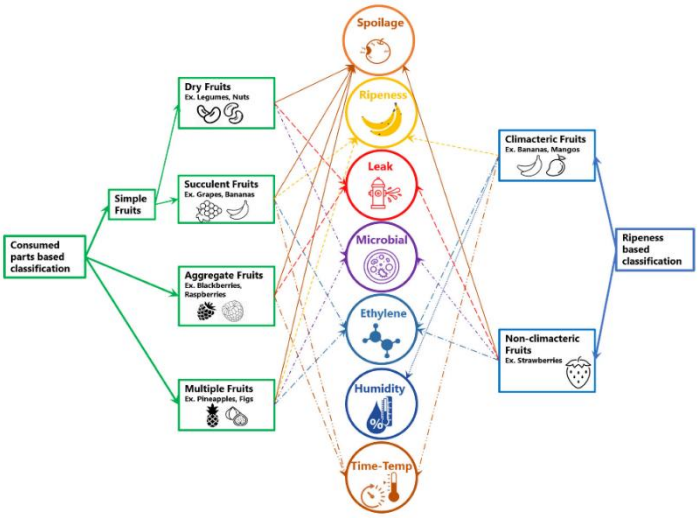

Fig 1: Classification of fruits according to consumed part and ripeness

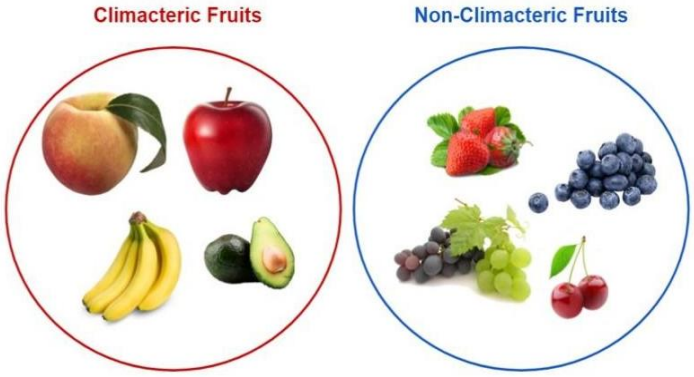

Fig 2: Examples of Climacteric and Non-Climacteric Fruits

Ripening agents

Some natural or artificial substances or chemicals can induce or reduce the ripening process of the fruits. They are called as Ripening agents.

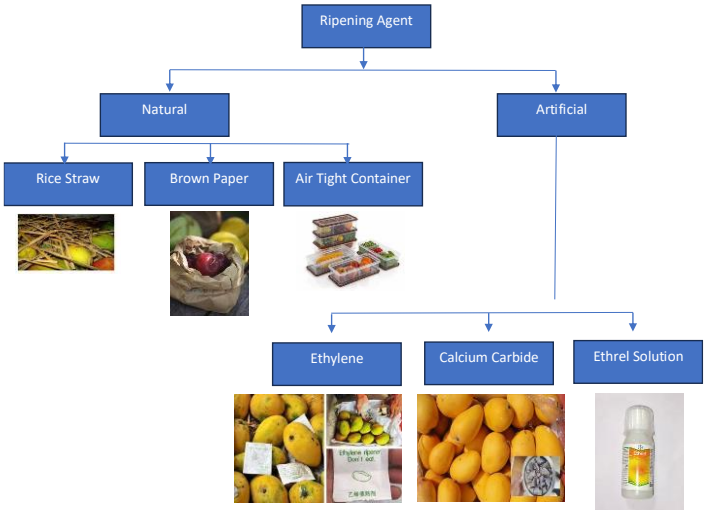

Fig 3: Classification of Ripening Agents

The commercial value of fruits will decline if it won't be at its desirable stage of ripeness, colour and texture. There are chances of damage and spoilage while carrying, transporting and packaging (Gandhi et al., 2016). To check this problem, we can use different methods of artificial ripening and packaging.

In case of Mango and other climacteric fruits, we can use different artificial ripening methods such as: -

Importance

Certain fruits have a short production period and storage life. Inconsistencies in fruit maturity and ripening variability are a major challenge in restricting the distance from the farmer to the consumer at the peak of its best ripening variability. The whole focus of proper packaging and handling for various fruits is highly necessary for the satisfaction of the consumer. The consumer-ready packaged product should withstand external damages like bruises, sap injury, deterioration, latex, uniform weight, colour and shape (Sivakumar et al., 2011). The fruits to be delivered have to represent the highest possible nutrient and antioxidant as in the parent fruit. Much of the nutrient loss or deficit of flavour is due to the improper maintenance of quality during the supply chain. The important purpose of treatment with $KMnO_4$ and ethylene during the packaging is to create a suitable ambience to extend the shelf life, hold the quality and the nutrient composition.

Active Packaging

The need for a proper ambient for transportation and deliverance of the food product grows with passing generation. For centuries, food materials have been delivered in some packaging, which involves traditional packaging material and has since evolved into more sophisticated forms. The competition in delivering high quality food has driven each food proprietor on pursuing a better and evolved packaging options. Giving rise to the need of active packaging (AP) which involves the use of oxygen absorbers, moisture absorbers ($KMnO_4$), ethylene absorbers, antioxidant releasers, carbon dioxide emitter and anti-microbial packaging systems. There are other technologies that can go along with active packaging, such as intelligent packaging. They include the sensor feature which will help to determine the current state of the food inside. An example would be to control the ripeness of the fruit (Bodbodak & Rafiee, 2016).

Merits

1. It maintains the freshness of the product.
2. Shelf life increases through active packaging techniques.

Demerits

1. Many foods spoil faster when oxygen is present in their packaging, causing off flavours, colour change and nutrient loss.
2. Active packaging increases the cost of the product.
3. Active packaging lacks recyclability of disposable.

Table 1: Types of active packaging, their application and benefits

Types of active packaging	Types of food	Potential Benefits
Active scavenging systems(absorbers)		
(I) Oxygen scavengers	Fruits, vegetable juices, seeds, nuts	Prevents discolouration, rancidity, browning
(II) Moisture scavengers	Strawberries, tomato, maize, grains, seeds	Elongates shelf life by sustaining moisture content
(III) Ethylene Absorbers	Apple, banana, mango, melon, apricot	Reduces ripening and keeps the product fresh
Active releasing systems (emitter)		
(I) Antioxidant releaser	Seeds and nuts, fried products	Improves oxidative stability
(II)Carbon di oxide emitter	Fresh meat products	Anti-microbial properties
(III) Anti-microbial Packaging System	Processed fruits and vegetables	Inhibits Bacterial growth and extends shelf life

Intelligent packaging

Intelligent packaging is a developing technology that uses the communication role of the package to enable decision making to attain the benefits of improved food quality and safety. In other words, its main function is to monitor quality of products. A sensor is used on the packaging that

denotes characteristics to convey its desirability. Simply observing the sensor's color allows customers to determine the fruit's level of ripeness. The handling and inspection of fruits by consumers may result in fruit damage and shrinkage, which can be reduced by the use of the sensor. The Polyethylene Terephthalate (PET) clamshell that is generally used for the sensor package is recyclable and can offer a more hygienic and environmentally friendly packaging (Janjarasskul & Suppakul, 2018).

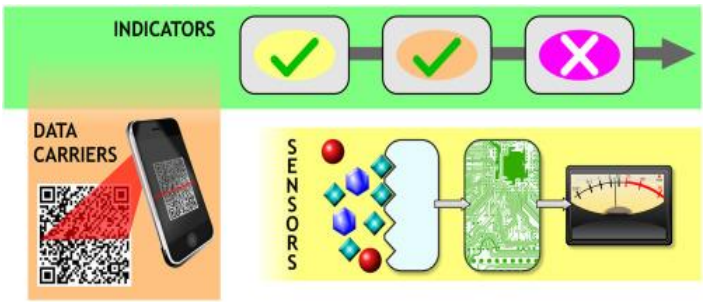

Fig 4: Active packaging with sensor

Merit

1. Intelligent packaging is easy to use for consumers.
2. Ensure higher product safety and in a minimization of unnecessary food waste.

Demerits

1. It should also be noted that it is not possible to totally depend on intelligent packaging for optimum product quality as misuse or failure of the systems cannot be ruled out.
2. Monitoring just one parameter cannot provide a complete statement about the quality status of a product.

Conclusion

In the ripening process, the fruits undergo various physiological changes such as changes in colour, texture and flavour. Climacteric fruits such as mango undergo ripening post-harvest due to a ripening hormone ethylene gas (C_2H_4). This ripening process after harvesting shortens the shelf life and microbial spoilage often leading to a decrease in its market value. To delay or prevent the ripening process and also the microbial spoilage there are various packaging methods and treatments available. Active packaging is one such packaging method where it is used to control the ripening process, thereby retaining the firmness and increasing the shelf life and also delay or prevent microbial spoilage. The use of advanced packaging methods helps in reducing food waste which is important for commercial purposes. Intelligent packaging on the other hand monitors the quality and communicates with the consumer about its desirability.

References

Bodbodak, S., & Rafiee, Z. (2016). Recent trends in active packaging in fruits and vegetables. In *Eco-friendly technology for postharvest produce quality* (pp. 77-125). Elsevier.

Gandhi, S., Sharma, M., & Bhatnagar, B. (2016). Comparative study on the ripening ability of artificial ripening agent (calcium carbide) and natural ripening agents. *Glob. J. Biol. Agric. Health Sci*, *5*, 106-110.

Janjarasskul, T., & Suppakul, P. (2018). Active and intelligent packaging: The indication of quality and safety. *Critical reviews in food science and nutrition*, *58*(5), 808-831.

Saltveit, M. E. (2005). Fruit ripening and fruit quality. In *Tomatoes* (pp. 145-170). Cabi Publishing Wallingford UK.

Sivakumar, D., Jiang, Y., & Yahia, E. M. (2011). Maintaining mango (Mangifera indica L.) fruit quality during the export chain. *Food Research International*, *44*(5), 1254-1263.

* * * * * * * *