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A Closer Look at How Artificial Base Apple Waxing May Impact Health and Fruit Quality

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Apple is one of the most popular, widely consumed and highly demanded fruits worldwide, valued for its nutritional value, sweet taste and year-round availability. It is also used as a food, medicinal and cosmetic ingredient. However, since it is a temperate fruit and is produced only in limited areas, various postharvest operations are carried out to ensure that it reaches places where it is not produced. We have been hearing since childhood that "an apple a day keeps the doctor away" but now we can say "an apple a day takes you to the doctor" because various wrong activities in apples spoil the quality of apples and this has adverse effects on human health. The apples are usually harvested over a restricted period, it is therefore necessary to provide storage for the fruits to regulate marketing and provide high quality produce to fresh and processing outlets on a year round basis because due to miss handling, lack of storage and transport facilities in the country the most of the apple fruit is wasted. In the harvesting season there is a glut of fruit in the market. In the same days farmers cannot get reasonable price, so it becomes imperative to prolong the shelf life of the fruit in the best interest farmer community and consumers as well. However, to maintain visual quality, extend shelf life and meet market demand, various post-harvest practices such as waxing, chemical treatments, and cold storage are routinely applied. Wax coating on apples is a process in which a thin layer of wax is applied to the surface of apples so that the fruit looks fresh for a long time and does not spoil. This is mainly done during transportation and storage. It is used to prevent water on the surface of apples from evaporating, keep the fruit fresh for a long time, maintain quality, extend shelf life, maintain flavor uniformity, and meet market demand. To maintain these things, various types of coatings are used on apples, which can be natural or artificial, naturally

speaking, beeswax, carnauba wax, shellac and nowadays, the FDA has certified polyethylene wax as good for health and has recommended its use. However, due to increasing demand, high transportation loss, physiological disorder and climate change, artificial coatings such as petroleum derived paraffin, Shellac with solvent base and non-degradable waxes on apples and improper post-harvest handling can pose a risk to both the quality of the fruit and human health. Artificial wax coatings made from synthetic materials such as paraffin or polyethylene-based compounds are used to increase surface gloss and reduce evaporation, delay ripening, retain natural flavor, and protect apples from uneven texture. However, these coatings can interfere with the natural respiration and ripening processes of the apple, and in some cases, can trap harmful residues such as pesticides or fungicides beneath the wax layer.

Additionally, the consumption of non-food-grade waxes and chemical-based mixture coatings has also raised human health concerns due to their indigestible and potentially toxic nature, leading to apple poisoning. In addition to apple cider vinegar, improper handling of apples, including improperly used fungicides, ethylene ripening agents, and improper and unhygienic storage or transportation conditions, can further compromise the safety and nutritional integrity of apples. These hidden and overlooked interventions are often underreported and poorly regulated, especially in low- and middle-income countries, exposing consumers to unnecessary risks. Therefore, coating materials are used to safely transport and store apples, but the repeated and layer-by-layer storage of apples to increase their brightness and shelf life can lead to deterioration of the quality of the product due to temperature fluctuations, so eating such apples can sometimes be risky. Quality degradation in fruits is not only caused by coating but also by many other activities, which are mentioned below.

Types of waxes coating used on apple

Generally, apples are coated with various types of substances to keep them fresh for a long time, to give them shine, and to prevent moisture loss, among which wax coating is the most popular. Natural wax like bee wax, carnauba, shellac and artificial wax like petroleum based paraffin, polyethylene base coating, morpholine compound etc. Both are used for coating but excessive use of artificial waxes can make the fruit toxic and deteriorate its quality. For example, petroleum based paraffin wax contains hydrocarbons, which are

non-biodegradable and can cause digestive problems. Similarly, polyethylene wax, and morpholine-based waxes are also commonly used, especially in industrial and export markets. These synthetic waxes provide long shelf life and high gloss but are not biodegradable and may not be metabolized by the human body.

Improper postharvest handling hazards

Waxes are used in the production of fruit to make it attractive, but after harvest and improper handling can significantly affect the quality of apples. These include blemished fruit, injury, attack by minor diseases/pests, some chemical residues, unhygienic handling, and misuse of ripening agents that interact with the use of waxes and deteriorate the quality of the fruit.

Pesticides residue entrapment under wax layers

Fungicides and insecticides used during apple cultivation sometimes remain on the surface if not washed off properly after harvesting, and when synthetic wax is applied, it can seal these residues under an impermeable layer, preventing natural decay and increasing the likelihood of direct ingestion by consumers. Studies have found residues of chemicals such as captan, carbendazim and chlorpyrifos in waxed apples far above maximum residue limits (MRLs), especially in unregulated markets where such activities are more likely.

Use of non-food-grade fungicides and preservatives

To prevent fruit rot during storage and transportation after picking, apples are sometimes treated with postharvest fungicides such as thiabenazole (TBZ) and imazalil. These are effective against pathogens such as Penicillium expansum but can also leave residues on the skin, especially when applied via dipping or fogging methods. Areas with poor supervision, such as general markets, markets and retailers, sometimes use industrial-grade or unlicensed chemicals to reduce costs. Such overuse increases the risk of chemicals and reduces fruit and microbiological levels.

Unsafe ripening practices

Nowadays, it is common practice in local markets to ripen fruits using ethylene based Ripening accelerants like ethephon or banned substances such as calcium carbide. These chemicals cause external color changes without corresponding internal ripening, making the apples appear ripe but such prematurely ripened apples lack flavor, aroma, attractive

color and nutritional value. In addition, calcium carbide releases arsine and phosphine gases, which are toxic and have been linked to gastrointestinal and neurological problems.

Biofilm formation on apple surface

When wax is used in a hostile or contaminated environment, sometimes the combination of wax and humidity creates ideal conditions where biofilm develops easily. Biofilm is a type of bacteria that is highly resistant to standard cleaning and disinfection, causing the risk of contamination from the very beginning, but unnecessary and repeated use introduces a biological hazard to the apple that is invisible to the consumer.

Strategy to Safer Alternatives and good practices:

Safer alternatives to synthetic coatings

Natural waxes can now be used in addition to artificial waxes for safe transportation and storage of apples. Recent studies have shown that biodegradable and artificial coatings like aloe Vera gel, chitosan, starch-based film and non-coating with an essential oil (anti-microbial) play a major role in maintaining the flavor, aroma and long-term shelf life and quality of apples while being safe for the consumer.

Enhance Postharvest activities

After harvesting, apples can be transported and stored safely until they reach the consumer by adopting various innovative techniques such as; proper sorting and grading and storage in controlled atmosphere storage, use of smart packaging and sensors that provide real-time quality monitoring along with dynamic packaging, bioactive and Nano-coatings can also be used to store apples for a long time and maintain their quality, thus making them available in the market for many days..

Policy recommendations and consumers awareness

Thus, the sale of substandard apples, especially in the local market, is becoming more common, so the relevant authorities should strictly check the quality of the apples right from the time of picking. Labeling should clearly indicate the type of coating used and its safety classification, and public awareness campaigns should be conducted to educate consumers about the risks of long-term consumption of such artificially coated apples. In addition, producers should be encouraged to move towards sustainable and food-grade

alternatives through policy support and certification programs.

Ways to Avoid waxy substances

When Apples brought from the market should be washed after being kept in lukewarm water for some time. Apples that are bought fresh and shiny should be consumed only after being washed in vinegar or baking soda water for some time.

Case studied:

In 2018, some farmers in Kolkata were found using santoor-paraffin to make apples shiny, which was revealed after municipality raids following complaints from consumers. Similarly, there were reports of apples being sold at high prices at Khan Market in Delhi using excessive waxes to make apples shiny, after which the consumer affairs minister raised the issue, and FSSAI decided to label the wax coatings appropriately. Many such incidents are heard from consumers which are not usually made public.

Conclusion:

To meet the nutritional deficiency in the human body, the demand for apples rich in nutrients is increasing in the market and based on this demand, many places are currently selling and distributing apples by using chemical mixture and artificial wax coating to increase the shelf life, but its long-term use can affect the quality of the product as well as the health of the human body. Eating apples coated with a substance called morpholine can combine with nitrites in the body to form nitrosamines (which can cause cancer), which is harmful to human health. So, now instead of saying "an apple a day keeps the doctor away", we can say "an apple a day takes you to the doctor". Therefore, it is important to be careful when using apples coated with such chemicals and artificial waxes, and as an alternative, coatings such as naturally coating agents, biodegradable and compostable should be used.

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