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Review paper

Studies on Eco-friendly stickers

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Abstract

Beyond expediting the checkout process, the labels carry significant information about the fruit's journey from farm to table. While applicable to vegetables, herbs, and nuts as well, fruits predominantly bear these labels, offering valuable insights into their cultivation methods. Each sticker contains the PLU (Price Look-Up) number, but that's not all. Produce stickers are full of information about the fruit and veggies you purchase at the supermarket. The objective of this paper is to provide a comprehensive overview of the existing situation and to study the Eco-friendly labeling of fresh fruits and vegetables.

Keywords: *Codes;Conventional Cultivation;Fruits and Vegetables;Genetically Modified;Organic Certification; Biodegradable Stickers.*

1. Introduction

A big reason to put stickers on fruits is so we can easily track them. As we trade more fresh fruits and vegetables worldwide, it's essential to have a way to follow them from the farm to the hands of the final consumer. The stickers generally have a 4 number code. This is used to know what kind of fruit it is, which the country of its origin is and who grows or sells them. This information helps in tracking the fruit's details, if there's a problem with food safety. Another reason for stickers on fruits is to help sell and identify its brands. The stickers might have the name or symbol of the farmer or seller on them. This can help people know more about the brand. Stickers can also inform customers about the weight or cost of fruit and if it's organic or not. This data can help customers to make better buying choices. India's Ministry of Agriculture and Farmers Welfare has started an effort to encourage using PLU labels on fruit and veggie foods. The initiative seeks to encourage the usage of organic fruits and vegetables while giving customers accurate and trustworthy information about the fruits and vegetables they buy[1].

Below is a simple guide on how to read PLU codes so you know what kind of produce you are buying.

- 4-digit PLU codes starting with 3 or 4: produce was grown conventionally or "traditionally" with the use of pesticides. I.e(3XXX or 4XXX)
- 5-digit PLU codes starting with 8: produce is a genetically modified, or genetically engineered (GE or GMO). I.e(8XXXX)
- 5-digit PLU codes starting with 9: produce was grown organically and is not genetically modified. I.e(9XXXX)

It is also not commonly known that the adhesive used to attach the PLU codes is considered food grade - but the stickers themselves are not edible [2].

The difference between Organic vs. conventional, is organically grown means natural fertilizers were used instead of synthetic chemicals. Organic farming uses compost and manure instead of chemical fertilizers. It uses insects and birds, and/or traps instead of synthetic pesticides. Crop rotation, mulching and hand weeding replace synthetic herbicides. Organic produce is usually grown without genetic engineering or modification. Conventionally grown means synthetic fertilizers and pesticides were used to promote growth and prevent disease. "Food labels can tell us a lot about what we're eating and help us make well-informed food choices for us Organic foods tend to be more expensive, due largely to limited supplies and additional labor and other costs to produce. we have options when buying conventionally grown produce, however. Just check which products have the lowest pesticide residue [3].

Genetically modified organisms or GMO produce are in a different category than organic and conventional produce. They've been the source of debate since they were introduced in the 1990s. GMO foods are genetically engineered in a lab to have certain characteristics. This may include resistance to certain pests and molds, a different color than the original plant, faster growing times, and larger fruit or even have higher values of certain vitamins. Many GMO crops grown in the United States are genetically engineered to be resistant to chemical pesticides. GMO fruits and vegetables were once assigned a five-digit PLU code number that started with the number 8. But the 8 prefix was dropped in 2015 as the GMO designation, and it was never used in retail. The International Federation for Produce Standards (IFPS), which assigns the voluntary PLU codes, says it plans to use the 8 prefix in the future for non-GMO produce.

The genetic manipulation of some foods has raised concerns about whether genetically engineered foods are as safe to eat as conventionally grown foods. The topic is still hotly debated even as there is no clear scientific evidence that GMOs are harmful to your health. The World Health Organization considers GMOs on the international market safe for consumption. The American Medical Association supports pre-market assessment of GMO food safety, but not mandatory GMO food labels. Within the Fresh Food sector, companies are focused on improving their business processes in the areas of location identification, product identification and data transport by means

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of electronic data interchange (EDI) and E-commerce applications, as well as the utilization of technologies like barcodes and Radio Frequency Identification (RFID) to realize efficiency benefits. One key area is the right labeling of consumer units and trade units, as this can lead – together with the usage by GS1 Standards for automatic identification (e.g. barcodes) – to significant improvements in the supply chain and faster processes in retail stores. Apart from the requirements between the business partners, it is necessary to provide on labels for consumer units and trade units the right information according to a number of relevant EU directives like EU 1169/2011 or EU 543/2011 and their national implementations. Based on a business view, this brochure aims to help companies in the fruit & vegetable sector and their business partners to have the same understanding regarding the legal requirements and provides guidance about the needed information on a label from a legal point of view too. Country of Origin (full name) is required for all fresh fruit and vegetable covered by the Regulation. Name and address of the packer and/or dispatcher must be stated for all packages. However for pre-packages the name and the address of a seller established may be indicated instead in close connection with the words "Packed for:" or an equivalent term. In this case the label must include a code representing the packer and/or dispatcher and the seller must be able to provide information regarding what the code means [4].

Other labeling requirements: Mixes of fruit or vegetables (for example mixes of citrus or mixes of lettuce/endives) or mixtures of different varieties of a single product may have specific additional labeling requirements not outlined. Traders presenting mixed product for sale should consult the full legal text for details. Exemptions - products not required to conform to the marketing standards: 1. Products intended for industrial processing or intended for animal feed or other non-food use provided they are clearly marked with the words "intended for processing" or "for animal feed" or any other equivalent wording. 2. Products transferred by the producer on his holding to consumers for their personal use. 3. Products having undergone processing, trimming or cutting making them "ready to eat" or "kitchen ready". Within a given production area, products sold or delivered by the grower to preparation and packaging stations or storage facilities, and products shipped from storage facilities to preparation and packaging stations[5].

Regulatory frameworks all around the globe have been primarily set up to achieve the objective of ensuring food safety and protection of consumer interests. Both these objectives require that regulators analyse the information on various food safety and regulatory aspects throughout the Food Chain, including estimating dietary exposure for carrying out scientific risk assessments. Keeping in mind the huge diversity in the food products being consumed, regions in which they consumed, the population groups involved etc., it becomes virtually impossible to track the information on an individual product basis. Apart from the shear volume of data, the problem gets further compounded by the use of multiple languages, dialects and regional variations [6].

The preparation of reliable data on food requires precise nomenclature and detailed description of foods. Even data of good quality can be a source of error if they are derived from foods that are not clearly defined. Moreover, it is difficult to exchange data on foods, or to understand and compare various parameters such as nutritional status, consumption patterns, risk analysis profiles etc. for different regions, states or individuals, without a coherent description of foods in databases

It may contain harmful chemicals which may affect human health. We generally remove the stickers from fruits or vegetables and consume them without thinking about residues of adhesive present on them. The risk of consuming these adhesives is high in case of fruits or vegetables consumed with skin. While the stickers that get placed on fruits and vegetables won't cause you any harm, it's probably best to remove them before eating. Because produce stickers have contact with food, the intended use of these stickers is the subject of premarket approval by the Food and Drug Administration, to ensure that any substance that may migrate to food from the use of the sticker is safe," said a spokeswoman for the agency in an email. "As these stickers are intended to be removed before consumption of produce, the F.D.A.'s review does not include the exposure that would result from regular consumption of these labels. However, as these substances are of low toxicity, any exposure from the occasional, unintentional consumption of a sticker would not be expected to be a health concern." There are three main components to the sticker, There's the ink, which spells out the PLU number; there's the substrate it's printed on (typically plastic, plastic composite or paper); and there's the adhesive, which makes it stick. "All three of those have to be safe for humans," Though the stickers are edible, they have no flavor and no nutritional value. And there is an environmental downside to not removing them before discarding skins, peels and other parts that you don't eat: Produce stickers are not home compostable, so they won't break down in the compost [7].

While you should wash your fruits and vegetables and remove the sticker before enjoying, if you accidentally consume one it likely won't cause harm. According to the International Fresh Produce Association (IFPA), the stickers can be ingested, and they will pass through you without being digested. The stickers contain food-grade ink and adhesives. Most aren't biodegradable or compostable, so be sure to remove them even from peels you don't consume before discarding them.

Compost, the most widely used soil amendment in the world, contains varying amounts of plastics. A main source of this plastic contamination is price look-up stickers, used internationally for the marketing and labeling of food. These fruit or vegetable stickers, usually made of vinyl or (conventional) plastic, are glued on the peel of various foods and frequently remain on the food material ending up in the organic waste. Due to their small size and thickness, these stickers often pass screening processes in composting plants, although there are currently no estimates of how many stickers end up in composting facilities. These stickers are used not only in the EU but also in other countries around the world, where they presumably also contribute to the plastic pollution of compost. In the USA, for example, the US Environmental Protection Agency (EPA) identified these stickers as a major contributor to plastic in compost [8].

The PLU stickers are often composed of vinyl, paper, or plastic. The FDA views the sticker adhesive as a food-grade ingredient. According to reports, the stickers are inedible but digestible. Despite the FDA's approval, the adhesive used on PLU labels contains some compounds harmful to human health, including rubber chlorides and several types of polymers.The first person to use produce stickers on a large scale was Tom Mathison, founder of Stemilt Growers. Seeing them as a potential marketing strategy, he included the name of his farm and later added a logo to show that his produce was organic. PLU codes were added in the 1990's. These 4-digit codes (sometimes 5-digit for organic produce) make identification easier - They store important information about the produce such as price, type, and origin. They can also sometimes have interesting or creative designs! These stickers can also help to prevent food waste at large grocery chains, the PLU codes are used to track inventory more accurately [9].

Unfortunately produce stickers are often not made from eco-friendly material - while they can help reduce waste in some areas, they also introduce waste of their own. While these stickers serve a purpose, their environmental impact is a growing concern.

The easiest way to remove them is through the scotch tape trick that is handy and will not bruise sensitive fruits, like mangoes, peaches, or apricots. You must cover the sticker with scotch tape and remove it all in one go. The objective of this paper is to provide a comprehensive overview of the existing situation and to study the labeling of fresh fruits and vegetables.

2. Began in the mid-1980s

Important to note that these codes are handed out by the International Federation for Produce Standards (IFPS). IFPS is a global organization that assigns codes to fruits being sold all over the world including in countries like Kenya. These codes have been used in supermarkets all over the world since 1990.
The whole idea for doing this is to make inventory checks. It's also to make supermarket checkouts for bulk fresh produce quicker and more accurate. The stickers can also be used to find out exactly how the apple or any other fruit or vegetable you're buying from your local supermarket was grown. These codes are known as PLU Codes, commonly known as Price Look-up Numbers and are divided into three different codes and sets of numbers.
"PLU numbers indicate the commodity, variety and growing method (conventional and organic) at the point of sale to enable the retailer to charge the correct price for the product," Ed Treacy, vice president of supply chain and sustainability for the Produce Marketing Association, says in an article published by How Stuff Works. If the fruit has 4 digits and the first digit is 3 or 4 it means the fruit has been sprayed with pesticides and must be thoroughly washed before consumption [10].
If the number of digits is 5 and the first digit is 9, this means the fruit is organic which is considered the best type. They have been produced without Synthetic (human-made) pesticides, herbicides and fertilizers.If the number of digits is 5, and the first digit is 8, it means the fruit has been genetically modified (GM). Genetically modified fruits or vegetables are not good for human consumption. According to World Health Organization (WHO), they are derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism. WHO says all GM foods should be assessed before being allowed on the market.
For companies like GS1, their approach to enabling fresh produce supply chain traceability is focused on the use of open standards to provide visibility of objects that are relevant to supply chains. GS1 leverages 5 keys which include Global Trade Item Number (GTIN) which identifies types of products at any packaging level, Global Location Number (GLN) which focuses on the Physical Locations, Serial Shipping Container Code (SSCC) for Logistic units, Global Individual Asset Identifier (GIAI) that Identifies a particular physical entity as an asset and Global Returnable Asset Identifier (GRAI) Identifies a physical entity as a returnable asset.
These GS1 standards are the global common language for traceability solutions and are used globally by more than one million companies. These standards help trading partners more easily comply with relevant regulatory requirements in their market.''Multiple paths to purchase, an increase in regulatory requirements and a growing need for information about the food we eat are creating complex supply chains that require accurate data, [11]

3. Various designs

The purpose of the stickers is to allow a cashier to read the code easily through a clear plastic bag, so there are some design requirements.For stickers with only a number, the type size has to be at least 14 points, and for newer PLUs, it has to include a barcode, which should be at least 10- or 12-point font. It should also have as much contrast as possible, with black lettering on a white background considered ideal. There is no maximum size for the font. Other than that, manufacturers are free to come up with their own designs showing in fig 1, and making some stickers a collector's item of sorts [12].



Fig. 1: Non Biodegradable Stickers.

4. Distinct categories of fruit labels

a) Conventional: A four-digit code denotes conventional cultivation. These fruits undergo growth using traditional farming practices, often involving pesticides and chemical fertilizers, potentially affecting soil health.
b) Genetically Modified: A five-digit code starting with the number 8 indicates genetic modification. These fruits are engineered to resist pests and may involve pesticide usage during cultivation. The most common types of genetically modified produce you'll find in U.S. grocery stores include:

- Corn
- Soybeans (primarily used in animal feed and vegetable oil, so it's unlikely that you'll be buying genetically modified soybeans directly)
- Potatoes
- Papaya (Hawaiian-grown papayas are more likely to be genetically modified)
- Squash

c) Organic: A five-digit code commencing with the number 9 signifies organic certification. Organic fruits are grown without synthetic pesticides or fertilizers, promoting soil health and environmental sustainability.
d) Produce codes are universal

No matter where you shop, the produce code for a banana (and all other fruits and veggies) will be the same. Whether you're buying bananas from a store in Calgary, a shop in Kentucky or a stand in Cologne, Germany, the PLU is the same (4011). Same goes for navel oranges (3107), seedless green grapes (4022) and even passion fruit (3038 for the granadilla variety)[13].

5. Making informed choices: pesticides, environment, and local support

- Pesticides and Health: While conventionally grown fruits may use pesticides, it's essential to remember that the pesticide residue levels on fruits typically comply with regulatory safety standards. Nevertheless, many individuals choose organic options to minimize potential pesticide exposure, especially if they have concerns about health or specific dietary preferences.
- Environmental Impact: The choice between conventional and organic farming also has environmental implications. Organic farming practices often focus on soil health and sustainability. These methods aim to minimize soil erosion, conserve water, and reduce chemical runoff. Supporting organic farming can be viewed as a way to promote more environmentally friendly agriculture.
- Local Farmers: Buying from local farmers at farmers' markets or through Community Supported Agriculture (CSA) programs supports your local economy, reduces food miles, and often ensures fresher produce. Local farmers may employ sustainable farming practices, even if they're not certified organic. Engaging in conversations with local farmers can provide insight into their farming methods [14].

6. Empowering consumer choices

As consumers, advocating for transparent food labeling can empower you to make informed choices. Some organizations and brands go beyond the basic labeling requirements, providing additional information about the fruit's origin, farming practices, and certifications. Supporting brands that prioritize transparency can be a way to encourage better information sharing within the industry. By considering these factors, you can make food choices that align with your nutritional needs, environmental values, and support for local agriculture. Understanding the meaning of fruit labels is an essential step in making informed decisions about the food you consume [15-16].

7. Biodegradability of produce stickers

The most common type of produce sticker is made from petroleum-based plastic. They are not biodegradable and need to be removed before composting. Some might argue that produce stickers are so small that removing them from compost is mostly a cosmetic issue. When reducing plastic waste we shouldn't only consider the size of the individual item. A huge proportion of those fruits and vegetables will have stickers. Despite good intentions, many of these tiny stickers mistakenly end up at composting facilities. Because of their small size they are easy to miss when you're putting fruit or vegetable scraps in your compost bin. They then make their way to composting facilities where removing them is difficult, expensive, and time consuming. These stickers also frequently show up in home or community compost bins.

Not to mention that their small size is a big part of the problem! They're easy to miss, difficult to pick out by hand, and at industrial composting facilities they can slip past the compost screening equipment. By dismissing small plastic stickers as inconsequential, we risk inadvertently contaminating compost and putting even more plastic into the environment. We can make sure that we remove plastic stickers before putting fruit and vegetable scraps into the compost, but PLU stickers do not need to be made from plastic in the first place [17]

8. Eco-friendly alternatives to plastic produce stickers

There are several different ideas for eco-friendly stickers showing in figure.2commonly discussed among sustainable producers:



Fig. 2 : Eco-Friendly Stickers.

8.1. Compostable

Produce stickers made from innovative bioplastics can stand up to the same conditions as petroleum-based plastic stickers! We might be little biased, but we think compostable stickers are the best option for produce! The sticker matches the intended end-of-life solution for the fruit peel or veggie scraps, and they can be safely put in the compost bin together.

8.2. Laser etching

This approach eliminates the need for stickers altogether. The PLU codes are directly etched onto the skin or rind of fruit and vegetables, a great option for produce with thick rinds. Unfortunately purchasing the equipment needed can be cost prohibitive for smaller producers.

8.3. Paper

While paper stickers may seem like a good solution, uncoated paper will not stand up to the moisture in fruit production and storage. Coating the paper usually involves using plastic, and then we are right back where we started! Paper stickers are also often not flexible enough to stick to uneven or very round fruits.

8.4. Recyclable plastic

Recyclable stickers are great for many applications; however they still need to be removed from the fruit before disposal. Recyclable stickers are not necessarily compostable and may still contaminate compost. For more efficient waste reduction, items that are frequently discarded together should be designed for the same disposal method[18].

9. Conclusions

1) Now we know the secret behind the use of stickers on fruits in grocery stores and the importance of the PLU code. These stickers not only provide information about their origin or if they were grown or organic they also help maintain a standard. As world trade grows, these codes made by the IFPS help track things. Even though some worry about the health effects of sticker glue, groups like APEDA and India's Ministry of Agriculture try hard to keep an eye on health safety.
2) The efficiency of composting facilities plays a crucial role in developing the circular economy. As we continue to build a more sustainable future, it's important that we are aware of the consequences of plastic use. Even small parts, such as plastic stickers, have the potential to cause big problems for the environment. Widespread use of compostable labels and stickers can significantly reduce compost contamination - bringing us closer to our goal of ending landfills

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