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# Detailed View of Food Product (Mushroom) Using 2D Barcode

M. Shanju[1*], P. Varsha[2], K. Subashini[3]
[1,2,3]*Student, Department of Food Technology, Bannari Amman Institute of Technology, Erode, India*

***Abstract*: Product life management (PLM) is a process that involves the planning, design, development, and management of a product from its inception to the end of its life cycle. In the context of mushroom production, PLM can be used to track and optimize various aspects of the mushroom growing process, including seed procurement, cultivation, harvesting, and distribution. One tool that can be utilized as a part of a PLM system is a quick response (QR) code, which is a type of barcode that can be scanned with a smartphone or other device to access information about a product. By using QR codes, mushroom growers and distributors can easily track the location and status of each batch of mushrooms throughout the production process. This information can be used to optimize the growing conditions and improve the quality and safety of the mushrooms. QR codes can also be used to provide consumers with information about the source and history of the mushrooms they purchase, enhancing transparency and trust in the product. Overall, the implementation of a PLM system utilizing QR codes has the potential to improve efficiency, quality, and sustainability in the mushroom industry.**

***Keywords*: QR codes, PLM system, smartphone, transparency, track.**

## 1. Introduction

The journey of mushrooms from farm to plate can be tracked and traced using a 2D barcode, which incorporates advanced technologies such as Product Life Cycle Management (PLM) and blockchain. The 2D barcode can contain detailed information about the mushroom's origin, cultivation, and transportation, as well as its nutritional value and potential allergens.

PLM technology enables the tracking and management of product information throughout its lifecycle, from design to disposal. In the case of mushrooms, this technology can be used to collect and store data about each stage of the mushroom's journey, including its growth, harvesting, packaging, and distribution. This information can then be accessed and updated in real time by all parties involved in the supply chain, from farmers to retailers and consumers.

In addition, blockchain technology can be used to ensure the integrity and security of the data stored in the 2D barcode. By creating a tamper-proof digital ledger, blockchain technology can prevent the unauthorized alteration of information and ensure that all parties involved in the supply chain have access to accurate and up-to-date data. The use of Product Life Cycle Management (PLM) and blockchain technology in tracking the journey of mushrooms from the farm to the plate via a 2D barcode can not only help in promoting transparency and accountability in the food supply chain but can also aid in exporting and increasing the shelf life.

Exporting mushrooms requires compliance with various regulations and standards, and the use of PLM technology can help in ensuring that all necessary data and documentation are in order. Furthermore, the use of blockchain technology can help in increasing the shelf life of mushrooms by ensuring that the conditions in which the mushrooms were grown, transported, and stored are recorded and monitored.

Overall, the use of PLM and blockchain technology in conjunction with a 2D barcode can help in promoting transparency, accountability, and compliance in the food supply chain, while also aiding in exporting and increasing the shelf life of mushrooms. This can ultimately lead to better quality and safer food for consumers, and more efficient and profitable supply chains for producers and exporters.

## 2. Literature Review

In [1], the goal is to provide a fundamental overview of the product-related environment of a typical organization before the development of PLM. They will be able to take part in their company's PLM Initiative more effectively as just a result of this understanding. Also, this chapter seeks to give PLM students a fundamental grasp of the business environment associated with products before the development of PLM.

In [2] the development of unique digital product lifecycle management (DPLM) solutions for use cases including the production and delivery of digital products is made possible by the proliferation of digitalization, sensory devices, cloud computing, and the internet of things (IoT) technologies. The rise in popularity of digital content distribution platforms online highlights the need for reliable technology to ensure the origin and uniqueness of these products.

The paper [3] proposes a double-chain architecture-based public blockchain for an agricultural supply chain system, focusing on the dual chain structure and its storage mode, resource rent-seeking and matching mechanisms, and smart contract. The findings demonstrate that the agricultural supply chain, based on a double chain structure, can consider the

*Corresponding author: shanju.fd19@bitsathy.ac.in

transparency and security of transaction information as well as the privacy of enterprise information.

In [4] data from the supply chain isn't always clear, accessible, or reliable. IBM Blockchain's permissioned blockchain solutions enable supply chain parties to communicate reliable data. This is more important than during disruptive times. Companies and consumers expect brands to ensure the authenticity of their products, while supply chain partners want better visibility and responsible sourcing to reduce disputes.

The purpose of this study [5] was to investigate the feasibility of creating an anaerobic digestate-fertilized mushroom substrate for the growth of oyster mushrooms (P. ostreatus). A typical mushroom substrate made of sawdust and wheat bran was employed as a control. The import/export patterns show that button mushrooms account for the majority of exports whereas oyster mushrooms are exported in far smaller quantities.

## 3. Materials and Methods

### *A. Farm visit*

During the farm visit (Figures 1 & 2), we observe the growing conditions and process, harvesting methods, packaging processes, type of mushroom, harvest date, location of the farm, and other relevant information and collected samples of the mushrooms produced on the farm if permitted. Labeling and storing the samples properly to maintain their quality for further analysis is shown in Figure 3.

Fig. 1. Milky white mushroom farm visit in Erode

Fig. 2. Oyster mushroom farm visit in Sathy

Fig. 3. Mushrooms collected from different regions

### *B. Sample preparation*

The collected samples of different mushrooms (White button, Oyster, Milky white) from different regions (Erode, Coimbatore, Karur, Salem, Trichy) were dried in the hot air oven at 105°C for 4 hours. The dried mushrooms were ground in a mixer and stored in air-tight bags for further nutritional analysis.

### *C. Product Life cycle Management (PLM)*

PLM stands for Product Lifecycle Management. It is a process used by companies to manage the entire lifecycle of a product, from its initial concept to its retirement from the market. PLM encompasses various stages, including product design, development, testing, launch, and ongoing support.

PLM of mushrooms refers to the management of the lifecycle of mushroom products, from their initial production to their eventual retirement from the market. This can include various stages such as cultivation, harvesting, processing, packaging, distribution, and sales. PLM of mushrooms may involve managing the quality and safety of the mushrooms, optimizing production processes, ensuring compliance with regulatory requirements, and managing the supply chain to ensure timely and efficient delivery of the mushrooms to consumers. By effectively managing the PLM of mushroom products, companies can improve efficiency, reduce costs, and enhance the quality and safety of their products

### *D. Blockchain technology in mushroom life cycle management*

Blockchain technology has the potential to revolutionize the food industry by promoting transparency, traceability, and accountability throughout the supply chain. Moreover, blockchain technology can also help in improving food safety by enabling real-time tracking and monitoring of food products. This can help in preventing foodborne illnesses and contamination, and ensure that food products are delivered to consumers in the best possible condition.

It records the origin, cultivation, packaging, and transportation of mushrooms. This information can be used to ensure that the mushrooms are grown by industry standards and regulations, and to monitor the conditions under which they are transported and stored. Moreover, blockchain technology can enable real-time tracking and monitoring of the mushrooms, allowing producers and distributors to quickly respond to any potential issues or concerns that arise.

### *E. QR Code*

QR (Quick Response) code is a type of two-dimensional barcode that contains information that can be read by a mobile device or scanner. QR codes are commonly used for marketing and advertising purposes, but they can also be used for product identification and tracking in the context of PLM.

In the case of mushrooms, QR codes can be used to provide information about the origin, cultivation, and processing of the mushrooms. This information can include details such as the variety of mushrooms, the date and location of cultivation, the harvesting and processing methods used, and any relevant certifications or quality standards. Overall, the use of QR codes in PLM of mushrooms can help to improve the quality, safety, and transparency of mushroom products, while also providing valuable data and insights to producers, distributors, and retailers. From a PLM perspective, QR codes can also be used to track the movement of mushrooms throughout the supply chain, from cultivation to consumption. This can provide valuable data on the efficiency of production and distribution processes, as well as the performance of different varieties of mushrooms in different regions and environments.


Fig. 4. *Graphical representation*

### *F. Physico Chemical Tests*

The results are shown in Table 1, 2 and 3.

*1) Energy/calories*

Testing the calorie content of mushrooms is crucial in determining their nutritional value and can be useful in designing a balanced diet plan, managing calorie intake, and determining the appropriate serving size. Comparatively, mushrooms collected from Coimbatore have higher calories.

*2) Protein*

Using the Kjeldahl method is divided into three major steps. The steps include digestion, distillation, and titration. At the end of these steps, the amount of ammonia released is then measured and this measurement is used to calculate the amount of protein present in the sample. Comparatively, mushrooms collected from the Coimbatore region have higher protein.

*3) Carbohydrate*

The carbohydrate content of mushrooms is relatively low compared to other plant-based foods, the type of carbohydrate presents in mushrooms and their associated health benefits make them a valuable addition to a healthy diet. Comparatively, mushrooms collected from Erode and Salem regions have lower carbohydrate values.

*4) Water Activity*

Water activity is an important factor to consider in the production and storage of mushrooms. By controlling the water activity level, it is possible to extend the shelf life of mushrooms, maintain their quality and safety, and improve their overall texture and appearance. The water activity of the sample was checked using a water activity meter.

*5) Moisture*

Loss On Drying (LOD) is a method used by moisture analyzers to measure moisture. In this procedure, the moisture analyzer weighs a sample, dries it with heat, and then weighs it again

*6) pH*

pH is also important in preserving the safety of mushrooms. The growth of some harmful bacteria such as Clostridium botulinum, which causes botulism, is inhibited in acidic environments. By maintaining a slightly acidic pH level, the growth of harmful bacteria can be controlled, reducing the risk of foodborne illness. All mushroom region mushrooms were slightly acidic.

*7) Ash*

Initially, 5g of the sample was weighed and taken for the estimation of ash content. This was done using a Muffle furnace.

*8) Fat*

By using Soxhlet extraction. Comparatively, Milky white mushrooms collected from Erode have higher fat content than other types of mushrooms.

*9) Total Fiber*

Overall, the milky white mushrooms collected from erode have higher fiber content (2.32 g) compared to other types of mushrooms.

*10) Bulk density*

Measuring the bulk density of mushrooms can also provide important information about their quality and freshness. Mushrooms that are denser generally have a higher water content, which can indicate that they are fresher and of better quality. On the other hand, mushrooms with a lower bulk density may have a higher percentage of air space, which can indicate that they are older or have been stored improperly.

*11) Water absorption capacity*

The water-absorption capacity is dependent on the contents of starch and fiber in mushrooms. Whereas, fresh oyster mushrooms have a high-water absorption capacity.

*12) Rehydration ratio*

The rehydration ratio is a measure of how much water is needed to rehydrate a dried food product to its original pre-dried state.

*13) Swelling Index (SW)*

The swelling index can also be used to compare different types of mushrooms or different batches of the same type of mushroom. For example, mushrooms with a higher swelling index may be preferred for certain applications because they require less water to be fully hydrated, which can be more efficient and cost-effective.

*14) Formalin test*

Formalin is a toxic substance and its use in food is illegal in many countries. The formalin test is a simple and quick method to detect the presence of formalin in food samples.

Table 1
Nutritional analysis of White button mushrooms

| SAMPLE & NUTRITIONAL VALUES | Karur sample 1 | Erode sample 2 | Coimbatore sample 3 | Trichy sample 4 | Salem sample 5 |
|---|---|---|---|---|---|
| Energy/Calories (kcal) | 20 | 19 | 21 | 17 | 16 |
| Protein (g) | 3.26 | 3.12 | 4.1 | 3.42 | 3.09 |
| Carbohydrate (g) | 5.2 | 2.36 | 3.23 | 3.41 | 2.36 |
| Water activity (aW) | 0.901 | 0.921 | 0.993 | 0.871 | 0.916 |
| Moisture (%) | 89.7 | 91.39 | 93.31 | 87.77 | 91.02 |
| pH | 6.8 | 7 | 6.5 | 6.9 | 7.1 |
| Ash (g) | 0.5 | 0.9 | 0.2 | 0.6 | 0.8 |
| Fat (g) | 0.36 | 0.34 | 0.25 | 0.34 | 0.32 |
| Fibre (g) | 1.23 | 1.43 | 1.47 | 1.34 | 1.26 |
| Bulk density (g/mL) | 0.66 | 0.72 | 0.74 | 0.63 | 0.69 |
| Water absorption capacity (g/mL) | 4.74 | 4.83 | 4.87 | 4.56 | 4.53 |
| Rehydration ratio (%) | 400 | 400 | 400 | 400 | 400 |
| Swelling index (g) | 254 | 272 | 284 | 268 | 256 |
| Formalin test | Absent | Absent | Absent | Absent | Absent |

Table 2
Nutritional analysis of Oyster mushrooms

| SAMPLE & NUTRITIONAL VALUES | BIT Sathy sample 1 | Erode sample 2 | Coimbatore sample 3 |
|---|---|---|---|
| Energy/Calories (kcal) | 37.6 | 41.8 | 39 |
| Protein (g) | 3.3 | 4.67 | 4.83 |
| Carbohydrate (g) | 5.1 | 6.43 | 5.24 |
| Water activity (aW) | 0.398 | 0.408 | 0.431 |
| Moisture (%) | 87.3 | 88.42 | 89.56 |
| pH | 6.7 | 6.9 | 6.6 |
| Ash (g) | 1.42 | 0.87 | 1.41 |
| Fat (g) | 0.41 | 0.35 | 0.46 |
| Fibre (g) | 1.63 | 1.76 | 1.89 |
| Bulk density (g/mL) | 0.54 | 0.52 | 0.56 |
| Water absorption capacity (g/mL) | 5.3 | 5.07 | 5.03 |
| Rehydration ratio (%) | 300 | 300 | 3 |
| Swelling index (g) | 422 | 381 | 376 |
| Formalin test | Absent | Absent | Absent |

Table 3
Nutritional analysis of Milky white mushroom

| SAMPLE & NUTRITIONAL VALUES | Erode sample 1 |
|---|---|
| Energy/Calories (kcal) | 50.3 |
| Protein (g) | 3.22 |
| Carbohydrate (g) | 6.8 |
| Water activity (aW) | 0.296 |
| Moisture (%) | 85.95 |
| pH | 5.8 |
| Ash (g) | 2.3 |
| Fat (g) | 1.05 |
| Fibre (g) | 2.32 |
| Bulk density (g/mL) | 0.8 |
| Water absorption capacity (g/mL) | 2.74 |
| Rehydration ratio (%) | 200 |
| Swelling index (g) | 432 |
| Formalin test | Absent |

## 4. Result and Discussion

A 2D barcode is that it allows for a more detailed view of the product than traditional labels can provide. For example, a 2D barcode can link to a website or online database that provides detailed information about the sourcing of ingredients, the manufacturing process, and any certifications or quality standards that the product adheres to. This information can be especially important for consumers who are concerned about issues such as sustainability, animal welfare, or fair labor practices and it could be linked to a database that provides information on products that are suitable for people with specific dietary restrictions, such as gluten-free or vegan diets.

## 5. Conclusion

Using a 2D barcode to provide a detailed view of a food product, such as mushrooms, can be a valuable tool for consumers who are interested in understanding the sourcing, production methods, and nutritional content of the product they are purchasing. It can also provide information on the sustainability and environmental impact of the product, which is becoming increasingly important for many consumers. Overall, the use of 2D barcodes on mushroom products can promote transparency and accountability in the food industry and help consumers make more informed purchasing decisions. As technology continues to advance, it will be important to ensure that the information provided through 2D barcodes is up-to-date and relevant and that it meets the changing needs and expectations of consumers.

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