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A Systematic Literature Review on The Development and Evaluation of Honeydew Pectin with Aloe Vera as Edible Coating

Muhamad Azri Rudi[1], Elizah Mohamed[1]*

[1]Department of Chemical Engineering Technology, Faculty of Engineering Technology,
Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author Designation

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Abstract: The biggest problem encountered by the food manufacturer is the loss of quality of food products during storage. Although there are natural, edible wax coating on the market right now, the risk of a person getting intestine and colon cancer are noticeable high because the coating itself is not easily digestible. There is numerous source of fruits that contain a certain amount of pectin that has the suitable properties and thus can be used as edible coating. This study will discuss all the available information of potential natural hydrocolloids substances extracted from natural fruits waste with acceptable amount of degree of esterification (DE). This study also summarizes the findings related to five selected plants which had been identified and proven to contain polysaccharides compound that can be used as natural edible coating with yield produced on different method of extraction. The identification of 32 selected literatures and filtered searched on electronic databases such as ResearchGate, ScienceDirect, Google Scholar, Scopus, Academic Journal Organization, PubMed, National Center for Biotechnology Information (NCBI) and Hindawi. In-depth findings and analysis of those articles revealed that the effectiveness of pectin produced are heavily dependent on the method of extraction and the degree of esterification. The performance of combination of two different types of coating namely aloe vera with honeydew pectin can also increase the general performance of the coating better than the chemical wax coating.

Keywords: Pectin, Natural, Honeydew, Aloe vera

1. Introduction

Fruit coating can contribute a lot in terms of protecting and conserving fruit products from any contamination in any form of physical, chemical and biological treat. A good fruit coating can slow down its deterioration and ripening while maintaining colour and flavour of the fruit without sacrificing its beneficial properties [1]. While fruit ripening can enhance the sweetness of the fruit, it can greatly reduce the firmness of the fruit and make the fruit exposed to numbers of pathogens and spoilage. The ripening process of fruits can still happen even after harvesting. This ripening process occurs due to ethylene production and respiration of the fruit itself. Ethylene is a fruit ripening phytohormones which

*Corresponding author: elizah@uthm.edu.my

is one of the plant hormone that can triggers many kinds of cell metabolism, including the ripening process.

Nowadays, the commercial fruit coating is made from artificial wax that can greatly enhance the appearance of the fruit making them very appealing to consumer. The most important quality component in commercial marketing is the appearance of the product itself and the artificial wax coating does a great job at making the fruit shiny and fresh even though has been stored for months. Despites the greatness of artificial wax, it may cause a health related problems as the ingredient of the wax are mainly comes from synthetic petroleum-based polymer [1]. The advantages and conveniences of polymers coating also contributes to the popularity of its usage. However, the polymers coating is mainly obtained and manufactured from non-renewable sources hence the by-product cannot be disposed easily and can be a threat to environment.

In this study, five selected fruits waste or peels that contain pectin were identified for its potential material that can be used as edible coating. The extraction method that corresponding with the yield produced are further studied. Through the selection of these pectins, the best possible combination for two coating can be achieved. These natural fruit coating might be the reasons of improved the overall consumer's health. The identified pectin sources in this study may provide an alternative to be incorporated in aloe vera gel intended for fruit coating.

2. Literature Review

The most important properties needed for a safe food coating is the ability to create some sort of barrier from the potential microbial threat to the surface of the fruit while maintaining and improve its appealing features. Pectin is the most suitable because of its properties and most crucial part is it can be obtained from fruits by-product. The existence of pectin may solve some of a problem faced by an artificial and synthetic such as composing and health hazard it may produce. Not only pectin can be made by using completely from natural resources, it also requires a low cost to produce [2].

Pectin are already found in form of additives in food, cosmetic and pharmaceutical industries as a thickening and emulsifying agent. Pectin is white in appearance and colloidal carbohydrate of high molecular weight consist groups of glycanogalacturonans and acidic structural polysaccharides usually within a ripening climacteric fruit usually can be obtained from honeydew melon. Peptic substances are a group of polysaccharides that mainly present within the primary cell walls and middle lamellae fruits. The pectic substances are highly related to hemicellulose and lignin structures as the pectic uses are largely influence the mechanical strength and adhesion between cells [3].

One of the approach of coating emulsions technology is it can be produced using a combination of different levels of hydrocolloid components such as natural lipids and resins. Plant fibre can be derived from fruit's cell walls that called pectin. Pectin has been reported as one of the main raw materials to obtain edible films by its low cost and renewable source. Pectin is one of the suitable material that can be used as fruits safe coating as its properties can inhibit microbial activities, reduce respiration rate and ethylene production within climactic fruits [4]. It can theoretically also extend and prolongs the fruits shelf-life of fruits due to the formation of barrier layer blocking the exposure of gas and moisture.

Most pectins are consist of linear polymers called D-α-(1-4) anhydro-galacturonic acid that can be extracted from the primary cell wall of a plants. A part of carboxyl groups of anhydro-galacturonic acid is esterified with methanol. Pectin polysaccharides can be categorized into three types based on the structure and molecules present [5]. In common, pectin consists of (1→4)-α-D-galacturonic acid molecules that linked to a couple of rhamnose residues in the main chain with arabinose, galactose and xylose in the side chains [6].

It was stated in a study that the uses of pectin as coating film can extend the self-life of avocados to over a month at 10 °C plus limiting the loss of moisture and slows down the respiration rate. The delay of texture changes and colour was also observed [7]. Another study with similar result shows that fresh-cut mangoes coated with pectin able to remain in good and acceptable condition on the eyes of consumer for over two weeks with some modification in coating formulation for example addition of sorbitol and beeswax [8]. Next, multi-layered coating has effective effect on restraining the microbial growth like fungus and mould on fresh-cut cantaloupe at 4 °C for up to 9 days. The multi-layer coating was done by the combination of chitosan, β-CD-trans and pectin [9]. Another study was conducted on fresh cut papaya resulting similar results with calcium chloride as cross-linked agent [10].

A series of optimization on the coating construction is crucial to prevent while prolonging the self-life of the fruits while keep the flavour contained. Although pectin coating are excellent coating to preserve the active compound like antioxidant and antimicrobials, the effect on the permeability of the active agents in coating formulation need further research and development [4].

3. Methodology

3.1 Literature/Articles/Research Paper Selection Strategy

The identification of selected literature and articles was searched using electronic databases such as ResearchGate, ScienceDirect, SpringerLink, Molecular Diversity Preservation International (MDPI), National Center for Biotechnology Information (NCBI), Frontiers, Hindawi. The Preferred Reporting Items for Systemic Reviews and Meta-Analyses (PRISMA) guidelines are used in this methodology. The total number of hits for the initial search was 225 articles. In this study, only 32 articles were selected as eligible resources.

3.2 Data Analysis

The main material that can be used as edible coating material is pectin. It is because of its properties that comparable to synthetic wax used in commercial coating for export fruits. Pectin can be obtained by multiple natural sources such as Hydrocolloids that can be defined as a colloid system where the hydrophilic polymers that derived from different types of plants, animal or natural polysaccharides that modified chemically. The hydrocolloids usually possess large concentration of hydroxyl groups and can be polyelectrolytes that have ionisable repeating groups and give structural while controlling plant cells rheology. The sources of natural pectin that can be identify by 255 of different journal. Out of all that, five examples which are honeydew, citrus, pequi, orange peels and hibiscus sabdariffa pectin filtered because of the complete properties and test conducted that can be evaluated thoroughly in this study. Finally, the best pectin evaluated in yield produced and suitability in tem of degree of esterification.

4. Results and Discussion

4.1 Evaluation of the potential fruit coating materials

Pectin has a numerous method that can be used in extraction process with each has their own advantages to minimise the acidic solvent used and also the time taken for extraction. Uses of strong acid, pH and time of extraction plays a big role in the yield produced. But the strong acid could create much threat to the environment as the waste need to manage properly. Because of that weak acid and alternative extraction method along with purification steps with alcoholic precipitation need to be used to reduce the potential environment threat. Hence, the need for a new product from a natural and waste product is encouraged not only because of the minimal cost required, but also would reduce the amount of harmful waste released to the environment. The material for the pectin can be obtained by the natural fruit's waste such as peels and seeds. **Error! Reference source not found.** shows the list of available

pectin product that can be obtained from the fruit's waste along with the maximum yield that can be produced with the right extraction method.

Although there is numerous research on the evaluation of pectin and its properties in the internet right now, very few of them are specific for the use in coating of fruits. Additionally, not all of them have the exact and complete information of the properties of the pectin itself. Not only have that, the some of the analysis of the final result such as condition, weight loss and colour of the fruit was not present in the research. Despite that, the comparison of pectin coating can be narrowed down into five types of natural pectin.

Based on the filtered research, the best material for the natural fruit coating can be concluded based on the criteria of the pectin such as the yield, and degree of esterification. The DE value that would be the indication of the classification of the pectin whether it is low methoxyl pectin (LMP) or high methoxyl pectin (HMP). The differences between the two of the LMP and HMP are the viscosity and its ability to hardening thus creating a protecting film that can be used in food coating application.

The pectin produced from multiple journal can be summarised in **Error! Reference source not found.**. Based on the filtered results on pectin form multiple journals, it can be concluded that the honeydew pectin produce the highest yield compared to other pectin. Not only that, the esterification value is also meets the requirement of a coating properties as the pectin would be able to hardening and create a thin film on the irregular surface of fruits. Low methylation pectin able to cross-link with calcium cations and form hard gels that would protect and create a protection so that the fruit can be protected from microbial and also acts as water barrier. Although the lack of information on the application on the fruits itself, based on the degree of esterification, the result should be similar to the orange peels pectin which has almost the same degree of esterification.

4.2 Honeydew Pectin with Aloe Vera Coating

Numerous studies have been made focusing on the application of pectin and aloe vera gel as a fruit coating. One of the great properties of aloe vera is their ability to withstand antiviral and antitumor either direct or indirectly [11]. Its benefits are also includes the stimulation of the immune system. The aloe vera gel are also great for maintaining moisture content because of the mucopolysaccharides properties that can helps binding humidity on any surface especially for fruits skin [12]. However, because of its low viscosity, aloe vera gel would not maintain its gel form in room temperature for a long time.

Studies conducted by several researchers shown that aloe vera coating can last for 20 to 45 days at 4 °C. The testing for aloe vera in room temperature were rarely successful because of its low viscosity. In order to solve that, research conducted by both Padmaja, 2014 and Meenakshi, 2017 concluded that aloe vera incorporated with pectin would increase the coating efficiency [13,14]. The properties of high methoxyl pectin can act as thickening agent for the aloe vera so that it can hold gel form at ambient temperature. The overall result made by Meenakshi, 2017 reveals that aloe vera coating with pectin as thickener shows that it is very beneficial in term of reducing weight loss while minimising fruit's physico-chemical of tomato fruit compared with uncoated one [14]. The hybrid coating successfully maintaining the structure and appealing of tomato fruits for 20 days compared to uncoated one which can last for 8 days at room temperature. The combination of honeydew and aloe vera in term of health and skin products are not within industries. With the degree of esterification of honeydew pectin exceeding the 50% mark, it can be categorized as high methoxyl pectin with thickening properties that would makes an even better coating than synthetic one.

Table 1: Potential pectin from plant/fruit materials

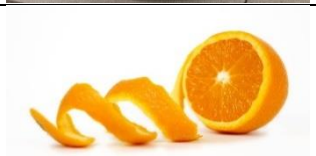
No	Plant material	Picture	Treatment	Max yield (%)	Reference
1	Hibiscus sabdariffa		Acid extraction	1.80	[15]
2	Honeydew melon peel		Acid extraction	35.26	[16]
3	Orange peel		Acid extraction	21.83	[17]
4	Pequi		Microwave assisted	20.79	[18]
5	Tangerine		Ultrasound assisted	18.89	[19]

Table 2: Comparison of pectin from various natural sources

Plant Material	Method	Type of solvent	Pectin properties		Result		Reference
			Yield (%)	DE (%)	Days	Weight loss (%)	
Hibiscus sabdariffa pectin	Acid extraction	citric acid	1.8	HMP	21 days 5 C	39	[15]
Honeydew pectin	Acid extraction	Citric acid	35.26	59.88	-	-	[16]
Orange peels pectin	Acid extraction	Hydrochloric acid	21.83	55.2	35 days 4 C	11.25	[17]
Pequi pectin	Microwave assisted extraction	Acetic acid	20.79	65.5	16 days 22 C	22	[18]
Tangerine, Citrus pectin	Ultrasound assisted extraction	Citric acid	18.89	72.15	5 days, 4 C	-	[19]

5. Conclusion

Based on this systematic literature review, honeydew pectin coating can maintain the structural integrity of fruits for more than 15 days in room temperature and up to 45 days in 4 ℃ temperature. With the combination of water barrier honeydew pectin together with aloe vera antimicrobial properties, the composite coating able to prolong the shelf life of fruits for more than 20 days at room temperature. Furthermore, the composite pectin can also compete with the commercial and synthetic coating because of the hardening and shiny effect of honeydew pectin. Pectin also plays important roles in term of increasing the viscosity of aloe vera coating hence prolonging the shelf life of the coating itself. The composite pectin also able to perform better with low temperature storage as the restricted movement and growth of microorganisms.

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