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El almidón, su uso y efecto como recubrimiento comestible en la conservación de frutas

Starch, its use and effect as an edible coating in fruit preservation

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Palabras claves: post cocecha, recubrimiento comestible, almidón, propiedades funcionales, frutas.

Resumen

Introducción: Las pérdidas pos-cosecha de frutas y hortalizas causadas por microorganismos, son altas debido a la falta de recursos tecnológicos y a la ausencia de sistemas de protección, lo cual provoca la baja competitividad de esta cadena de valor. Es por esto por lo que, varios investigadores se han enfocado en la búsqueda de nuevas técnicas que sean amigables con el medio ambiente y prolonguen por más tiempo la vida útil de los productos en la cadena hortofrutícola. **Objetivo:** El presente trabajo tuvo como objetivo principal recopilar información sobre el almidón, su uso y efecto protector como recubrimiento comestible en la conservación de frutas, haciendo énfasis en las bondades que estos generan, además de conocer el almidón más utilizado en la elaboración de estos. **Metodología:** Fue de carácter teórico - descriptivo, gran parte de la información que compone el siguiente documento proviene de varias fuentes electrónicas como: revistas (*SciELO, Dialnet, Innovative Food Science*), reportes técnicos, normas, tesis, todos elegidos de acuerdo con los criterios de selección. **Resultados:** En base a los resultados evidenciados en distintos estudios se deduce que el almidón es una alternativa interesante para la conservación de frutas, ya que actúa como una barrera protectora evitando la pérdida de peso, conserva por más tiempo las características sensoriales, y prolonga la vida útil de los frutos por más tiempo. **Conclusiones:** Por lo que se concluye que el almidón es considerado como un producto prometedor, siendo el almidón de yuca el más utilizado para crear recubrimientos, al ser un recurso de alta disponibilidad, fácil biodegradabilidad y amigable con el medio ambiente. **Área de estudio:** Ingeniería en alimentos.

Keywords: post-harvest, edible coating, starch, functional properties, fruits.

Abstract

Introduction: Post-harvest losses of fruits and vegetables caused by microorganisms are high due to the lack of technological resources and the absence of protection systems, which causes the low competitiveness of this value chain. That is why several researchers have focused on the search for new techniques that are environment-friendly and prolong the useful life of products in the fruit and vegetable chain for longer. Objective: The main objectives of this work were to collect information on starch, its use and protective effect as an edible coating in the preservation of fruits, emphasizing the benefits that it generates and to find out the starch most used in the preparation. Methodology: It was theoretical-descriptive, much of the information that this document presents comes from various electronic sources such as: journals (SciELO, Dialnet, Innovative Food Science), technical reports, standards, theses, all chosen according to the selection criteria. Results: Based on the results evidenced in different studies, it is deduced that starch is an interesting alternative for the preservation of fruits, since it acts as a protective barrier avoiding weight loss, preserves the sensory characteristics for longer, and prolongs the shelf life of the fruits for a longer time. Conclusions: Therefore, it is concluded that starch is considered a promising product, cassava starch being the most used to create coatings, as it is a universally available resource, easy to biodegrade and is friendly to the environment. Study Area: Education.

Introduction

Fruits are highly perishable agricultural products, due to the metabolic activity that continues even after being harvested, and at the same time to their high water content that facilitates the living conditions necessary for the development of fungi and bacteria, thus causing rapid destruction. and extensive tissue development throughout the anatomy of the product, decreasing the quality and commercial value of the fruit (Food and Agriculture Organization of the United Nations [FAO], 2004. p. 8).

Worldwide, post-harvest losses of fruits and vegetables caused by microorganisms are of the order of 5-25% in developed countries and 20-50% in developing countries. The difference is that developed countries have greater availability of technological and economic resources to prevent losses. However, in developing countries where post-harvest losses are high due to the lack of technological resources and the absence of protection systems, which causes the low competitiveness of this value chain, seriously limiting its improvement and directly affecting the economy of merchants (Infoagro. 2019.p. 1).

Due to the aforementioned, several studies have focused on the investigation of various conservation techniques that help reduce food deterioration, referring to the use of edible coatings, as an alternative for post-harvest conservation.

According to Fernández et al. (2015), an edible coating (CR) can be defined as a continuous, edible and thin transparent matrix, which is formed around a food in order to preserve its quality, reduce the proliferation of microorganisms and serve as packaging. The present research aims to compile existing information on starch, its use and its protective effect as an edible coating in the preservation of fruits (p. 53).

Methodology

Information search: The present study was of a descriptive theoretical type. The methodological route that has been followed basically included four moments: search, organization, systematization and analysis of electronic documents, without language restriction, related to the topic of edible starch-based coatings (Alves, 2016).

In order to meet the proposed objectives, the research focused on a selective bibliographic review and a deep critical analysis of the data obtained related to the study parameters. To locate the documents, several documentary sources were used through the Internet with the help of the "Google academic" search engine using the databases of magazines such as: Revista Ciencias Técnicas Agropecuarias, Innovative Food Science and Emerging, Cogent Food & Agriculture, SciELO, Dialnet , International Journal of Biological Macromolecules, Revista Iberoamericana de Tecnología Postharvest, among others. Much of the qualitative and quantitative information that makes up the following research comes from various sources, both primary and secondary, such as: books, magazines, technical reports, standards, theses, all electronic documents, and the search was completed with the reading and tracking of bibliography referenced in the selected documents, in order to provide a good basis and a global vision of the topic, which were prioritized according to the hierarchy of scientific evidence.

Selection criteria: For the analysis of the documents, some selection criteria were established, which were useful for the collection of information that was used during the research process, so the following parameters were proposed:

Information with a high level of validity, that is, it is found in recognized and better valued "academically" formats such as: books, magazines, conference proceedings, technical reports, standards, theses and the Internet, where 90% of the information belongs to the last 5 years and 10% corresponds to previous years, in languages both Spanish and English and in relation to the geographical scope, it focused on national and international countries, in addition, easily accessible documents with quality information were taken into account. As search criteria, the following descriptors are included: "Starch", "edible coatings", "edible coatings", "starch" "effect of coatings". These keywords were combined in various ways at the time of exploration, with the aim of expanding the search criteria. The records obtained ranged between 30 and 40 records after combining the different keywords.

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When searching for the documents, in each of the databases, several articles and documents will be pre-selected from which those documents that were found most suitable were chosen according to the inclusion and exclusion criteria. It is worth mentioning that those documents that do not provide adequate information will not be taken into consideration for the analysis.

Information systematization methods: For this research work, graphs, tables and charts were used where the systematized and important information that was fundamental for the realization of results, discussions and conclusions was placed.

Results

The results obtained are presented below:

Table 1

Use of starch in the production of edible coatings

Variables	Alvis et al. (2008)	FAO (1997)	Ibarra et al. (2010)	Cevallos (2007)	Hernandez (2008)	Average
Yucca	14%	-	28%	17%	17%	19%
Dad	24%	23 %	23 %	twenty-one %	twenty-one%	22.4%
Wheat	-	26%	74%	23 %	-	41%
Corn	-	28%	28%	30%	28.3%	28.57%

In Table 1, you can see the values of the amylose content in the starches commonly used for the production of coatings and edible films.

In this sense, the influence of the amylopectin content in the edible coatings is shown, based on the starches represented in the table and its effect on the, using corn starch (3%), presented a loss of quality in the fruits without coating from the third day, while the papaya with corn-based coating was maintained for 15 days compared to the uncoated treatment. Amaiz et al. (2019), reported an optimal texture during the 24 days of storage in the fruits coated with cassava starch (7%) while in the uncoated fruits the texture was optimal until day 12 (p. 137), this parameter It is important because it presents the loss of turgor due to the senescence of the fruit. Achipiz et al. (2013), evaluated a coating with 4% potato starch on guava, where they evidenced the acceleration in ripening and the loss in quality of the control sample, observing that the fruit with coating was the most efficient, increasing by 10 days life and avoiding weight loss (p. 98).

According to the results reported, the corn coating exhibited a better barrier capacity, and extended the useful life of the papaya for longer, in turn it was the one that presented the highest amount of amylose after wheat. This is justified because the amylose-amylopectin ratio significantly influences the function of the coating. This is how starches with a high amylose content provide better mechanical characteristics, preventing weight loss and preserving the texture of the fruit for longer.

This is based on what was mentioned by Ribba et al. (2017), who states that the amylose content, the length and location of the branches in amylopectin are the main determining factors of the functional properties of starch, such as water absorption, gelatinization, sticking, retrogradation (p.38). This is how the origin of the starch influences the optical properties and thickness: with more amylose, the films are opalescent and thicker; with less, they are transparent and thinner. Zapador & Chiral (2018) state that high-amylose starches exhibit better packed domains, better retain weight losses and firmness for longer periods than medium-amylose starch coatings (p. 7).

Table 2 shows the weight loss of different fruits, with the control samples presenting greater loss, unlike the treated fruits, which retain their weight for more days.

Of all the treated fruits, it is distinguished that the coating that best acted as a barrier preventing weight loss was the modified cassava starch, applied to strawberries with a loss difference of 20.48% compared to the control sample, this is due to that for the preparation of this coating, modified starch was applied, which considerably improved the physical characteristics of the coating, preventing moisture loss. This is how other researchers emphasize the importance of using this type of starch in coatings. García et al. (2018), mentions that modified starch has been used to stabilize functional properties, showing a homogeneous surface and a decrease in water vapor permeability, compared to the control (p. 35).

Decreased weight loss

Table 2

Influence of starch RC on fruit weight loss

Matrix	Additives	Fruit	Weightloss (%)		Weight loss difference	Reference
			SR Fruit	CR fruit		
starch cassava (4%)	Citric acid Glycerin Cinnamon essential oil	Tomato 22 days	14.81%	8%	6.81	Barco et al. (2011)
banana starch 4%	Chitosan Glycerol	Straw berry 8 days	24%	17%	7%	García et al. (2018)
Chinese potato (2%)	Potassium sorbitol sorbitol Citric acid	Straw berry 16 days	18.46%	12.67%	5.79%	Onate (2018)
Modified starch of cassava	Sorbitol plasticizers	Straw berry 8 days	53.44%	32.96%	20.48%	Franco et al. (2016)
Yucca 4%	Bee wax glycerin and Carboxymethylcellulose	Chontaduro 8 days	22%	eleven%	eleven%	Tosne (2014)

García (2017) indicates that the weight loss in the fruit is due to the possible exchange of gases during the respiration and transpiration process that reduces the water content, which generally occurs in fruits (p. 6). This is how Rocha et al. (2017), mentions that fruits coated with polysaccharide-based films tend to delay mass loss because the gel applied to the fruit loses moisture before the coated food dries (p. 3).

The above is in agreement with what was reported by other researchers, who found that the application of edible coatings on fruits and vegetables inhibits weight loss, avoiding texture changes and surface shrinkage, thus preventing it from negatively affecting shelf life. of climacteric fruits and vegetables. Which proves the efficiency of the coatings and shows the potential use of starch in the production of edible coatings.

Extension of useful life time

According to León (2015), the useful life is the time during which the food retains all its qualities. The end of the life of a food not only depends on maintaining minimum levels of contamination, but also on preserving its physical-chemical (homogeneity, stability, structure) and organoleptic (texture, flavor, aroma) qualities (p. 27) .

Table 3

Starch coatings and their influence on the shelf life of fruits

Matrix	Additives	Fruit	Time of life SR Fruit	Useful life (days) CR fruit	Increased useful life (days)	Reference
starch cassava 5%	Glycerol Ascorbic acid Others	Harton banana	twenty	32	12	Marquez et al. (2015)
Cassava 4%	Bee wax, Glycerin others	Chontaduro	12	16	4	Tosne (2014)
Yucca	Olive oil, glycerol, others	tree tomato	12	17	5	Andrade et al. (2014)
Cassava 7%	Glycerin	Guava	12	24	12	Amaiz et al. (2019)
Cassava 2.5%	Glycerol, Chitosan, Glacial acetic acid	Guava	4	14	10	Ferreira & Camilloto (2018)

Table 3 shows the influence of starch coatings on the shelf life of fruits.

The edible coating based on cassava starch provided longer shelf life to the coated fruits, such is the case of banana and guava, which extended the shelf life by 12 more days compared to the control sample, its attributes such as color, aroma, weight loss were maintained during the 24 days.

This parameter is greatly influenced by the amount of starch used in the preparation of the coatings. In both fruits, a higher concentration of this biopolymer was applied compared to the other formulations, so a greater amount of starch creates thicker coatings that help maintain firmness and prevent moisture content from being easily lost, hence the decrease. of energy metabolism, favoring the maintenance of firmness for a longer period of time, delaying the progress of fruit ripening and maintaining sensory characteristics for more days.

This can be explained by referring to the concept of Cusme & Gómez (2019), who in their study mentions that, by increasing the concentration of starch, the adhesion and flexibility of the coating on the surface of fruits is improved (p. 25). However, starch concentrations of 2% caused apparently dehydrated and opaque fruits, in addition to being brittle and fibrous coatings. In turn, Ferreira & Camilloto (2018) indicates that as the concentration of cassava starch in the suspension increased, the values presented a lower loss, due to the reduction in water loss from the fruit, caused by the increase. of the coating thickness (p. 282).

Compared to other coatings, the starch coating has better characteristics and prolongs the storage time of the fruits for more days. Jimenes (2020), studied an aloe vera-based coating on guava, reporting an increase of 8 more days for the useful life, compared to the sample (p. 15.). While Amaiz et al. (2019), I applied a coating with 7% cassava starch to the same fruit, this being the most effective, because it increased the shelf life by 12 more days compared to the control sample.

In this way, it can be said that starch coatings are a convenient alternative that allows maintaining the physical, chemical and sensory attributes of agricultural products, extending their useful life, reducing post-harvest losses.

Color conservation in the fruit ripening process

According to the literature, starch coatings form a barrier which decreases the respiration rate, slowing down metabolic changes, slowing the disintegration of chlorophyll and decreasing the concentration of carotenes that give the fruit its yellow color. In this case, together a delay is evident. in the production of ethylene which accelerates these biochemical processes, which stimulate the genes that are responsible for the synthesis of certain enzymes, which degrade pigments that cause color change in the fruits (Simbaña, 2019, p. 34).

One of the main characteristics to indicate the fruit ripening process in the postharvest phase is the color of the skin. The loss of the green color of the peel is due to a breakdown in the chlorophyll molecular structure, which involves the enzyme chlorophyllase (Ferreira & Camilloto, 2018, p. 283).

Table 4 shows the influence of starch RC on fruit color.

Table 4

Influence of starch-based RCs on fruit coloration

Matrix	Additives	Fruit	ToC of alm.	Coloration		Reference
				SR Fruit	CR fruit	
Cassava 6%	-	Guava "Paluma"	3°C	Yellow	Dark green	Rocha et al. (2017)
Cassava 2.5%	Glycerol Chitosan Glacial acetic acid	Guava	22±2°C	Yellow	Green	Ferreira & Camilloto (2018)
Cassava 4%	Glycerin Thyme essential oil Vinegar	Pepper	25°C	Green reddish	Green	Bolaños (2014)
banana starch and avocado	Glycerin Ac. Asc. Ac. Citric Potassium sorbate	Papaya	7°C	Light green	Green dark	Chapuel & Reyes (2019)
Cassava 15%	Glycerol	Tomato Kidney	18°C	Red	pinton (pink)	Pilataxi (2017)

It can be seen that edible coatings produce a significant effect on the fruit, preventing the skin from changing color, unlike uncoated fruits that show color changes.

Several studies report positive effects of these coatings. Rocha et al. (2017), observed that guavas coated with cassava starch in concentrations of (4 and 6%) maintained the color of the peel greener than the control (0%), promoting the delay of yellowing of the peel compared to the control (p.5). Ferreira & Camilloto (2018) reported a similar result, from cassava starch coatings, which kept the guavas green during the 12 days of storage, while the skin color of the control group changed from green to yellow in just one day. 4d (p. 283). Bolaños (2014) indicates that the decrease in green color in the peppers was notable, starting from a percentage of green color between 56.1 and 57.55 and ending between 11.17% and 11.56% on day 17 (p. 798). Chapuel & Reyes (2019), using avocado and banana seed starches for papaya, formalized that the refrigerated fruits changed their dark color to a lighter green color after 18 days (p. 118). Pilataxi (2019), prepared a 15% cassava starch coating after 22 days, showing minor alteration in terms of color, preserving them at maturity stage 4 (Medium Pintón) at 3°C, presenting good commercial maturity for tomatoes (p. 44), being within the quality parameters established by (NTE INEN 2832:2013) (Ecuadorian Institute of Normalization [INEN], 2013. p. 6). While the control fruits presented more pronounced color changes, reaching the maximum degree of maturity at room temperature 18°C.

From the results evidenced in different studies, it is deduced that edible starch coatings are an alternative to prevent post-harvest loss of fruits, because they act as a good protective barrier that prevents the loss of water, volatile substances, slows down the losses of their sensory characteristics, and prolong the useful life of the fruits for longer. This is how starch is considered a good material for making edible coatings, falling within the definition established by the regulations (NTE INEN 1751:96) (Ecuadorian Institute of Standardization [INEN], 1996, p. 3), where it mentions that a coating is one that protects the surface of the fruit with substances such as oils, vegetable waxes and other products with the purpose of reducing wilting, wrinkling and improving appearance.

Starch most used in the production of edible coatings

Since there is not enough bibliographic information available for the construction of the comparative table, the results obtained are indicated descriptively.

It could be seen in different studies that cassava starch, unlike other starches, stands out for being the most used in the preparation of edible coatings. After verifying its effectiveness, it is considered an excellent raw material for making CR. According to Andrade et al. (2014), points out that cassava starch has been widely received because it has a good appearance, is not sticky, is a highly available resource in various parts of the world, is shiny and transparent, improves the visual appearance of the fruit and It can be removed with water, which represents a potential alternative to be used in the preservation of fruits and vegetables (p. 2).

Conclusions

- Starch has a high potential for use in the production of edible coatings according to the extensive number of investigations found, which highlight the effectiveness of this polysaccharide, in addition to emphasizing its availability and biocompatibility as a raw material, which leads to its consideration. as an excellent alternative for the protection and conservation of fruits and vegetables.
- Edible starch-based coatings have shown to have a growing boom in recent years due to the multiple benefits they generate, their use constitutes a future alternative for conservation of fruits and vegetables since it prevents weight loss, thus mentioning the case of strawberries where a loss of 20.48% was avoided compared to the control sample, it also provides longer shelf life to the coated fruits, such is the case of banana and guava where starch-based CR was used and the shelf life was extended by 12 more days compared to the control sample, produces a delay in ripening, thus cassava starch coatings applied to guava managed to maintain green during the 12 days of storage while the skin color of the control group changed from green to yellow in just 4 d, it has barrier properties that prevent the flow of gases, evidencing a lower degree of deterioration in the

fruits, providing added value and improving product quality for an extended period of time.

- Various studies use starch as a base to make edible coatings, extracted from different sources such as; corn, potato, green, and cassava, the latter being the most used to create these products, because cassava has attributes that make it very popular in relation to the others, for being a highly available resource in various parts of the world. world, it has a high performance as a raw material, it has easy adhesiveness on the product, it is also known for having properties that favor the formation of coatings, among which the ability to gel and the ease of molding stand out.

Conflict of interests

The authors declare that there is no conflict of interest in relation to the article presented.

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