RGSA – Revista de Gestão Social e Ambiental
ISSN: 1981-982X
Submission date: 11/11/2024
Acceptance date: 01/13/2025
DOI: https://doi.org/10.24857/rgsa.v19n1-120
Organization: Interinstitutional Scientific Committee
Chief Editor: Ana Carolina Messias de Souza Ferreira da Costa
Assessment: Double Blind Review pelo SEER/OJS

PRODUCTION OF EDIBLE COATING FOR PRESERVATION OF GUAVA (Psidium guaiava L) FROM RAW RESIDUE DERIVED FROM PROCESSING OF CASSAVA FLOUR (Manihot esculenta crantz)

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ABSTRACT

Objective: The present work aimed to use crueira, waste from the processing of cassava flour, to develop an edible coating to be applied to guavas of the Paluma variety, for the purpose of post-harvest conservation.

Theoretical Reference: The agricultural production of the Brazilian economy places the country in a prominent position on the international scene, at the same time as it is also a reference in supplying the domestic market with fresh products and their derivatives. However, given the perishable nature of products, much is lost throughout the entire production chain, and this volume is even increased when considering the generation of waste recommended for food processing. For example, you can mention the generation of waste from the production of cassava flour, which has underutilized areas and is generally disposed of improperly, causing environmental and social impacts.

Method: Different formulations were tested using three variables: cassava raw (6%, 7% and 8%), glycerol (3%, 4% and 5%), immersion time (5 min, 10 min and 15 min) in six storage times (0, 2, 4, 6 and 8 days). Our fruits were analyzed for mass loss, pH, titratable acidity, total soluble solids, reducing sugars and sensory analysis for color, general quality and incidence of rot.

Results and Discussion: Microbiological analyses were performed on the coating that presented the best conditions for preserving the fruits to verify the incidence of Salmonella, Bacillus cereus and Escherichia coli, and the microbiological results were within the requirements of current legislation. Under the conditions of the experiment, the coatings developed presented positive results for the preservation of guavas, delaying signs of ripening and increasing their shelf life, with emphasis on the coating composed of 6% cassava pulp and 3% glycerol, applied for 5 minutes, which presented better preservation characteristics for guavas in general.

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Implications of the Research: Contribute to the reduction of post-harvest loss of fruits and, consequently, impact on the supply of quality food for the population.

Originality/Value: Reuse of waste generated in the production of cassava flour, an agro-industry of interest to several regions of the country, in the production of low-cost edible and natural coating, which directly impacts the preservation of fresh food, reducing waste, increasing the food supply, thus contributing to food security.

Keywords: Cassava Crueira, Fruit Coating, Post-Harvest Preservation.

PRODUÇÃO DE REVESTIMENTO COMESTÍVEL PARA CONSERVAÇÃO DE GOIABA (Psidium guaiava L) A PARTIR DO RESÍDUO CRUEIRA DERIVADO DO PROCESSAMENTO DE FARINHA DE MANDIOCA (Manihot esculenta crantz)

RESUMO

Objetivo: O presente trabalho objetivou a utilização da crueira, resíduo do processamento da farinha de mandioca, para desenvolver um revestimento comestível a ser aplicado em goiabas da variedade Paluma, com a finalidade de conservação pós colheita.

Referencial Teórico: A produção agrícola da economia brasileira coloca o país em posição de destaque no cenário internacional, ao tempo em que também é referência no abastecimento do mercado interno com produtos in natura e seus derivados. No entanto, dado o caráter perecível dos produtos, muito se é perdido ao longo de toda a cadeia produtiva, e tal volume é ainda aumentado quando se considera a geração de resíduos advinda do processamento de alimentos. A exemplo, pode-se citar a geração de resíduos da produção de farinha de mandioca, que tem seus refugos subutilizados e geralmente direcionados a um descarte indevido, acarretando impactos ambientais e sociais.

Método: Foram testadas diferentes formulações sendo utilizadas três variáveis: crueira de mandioca (6%, 7% e 8%), glicerol (3%, 4% e 5%), tempo de imersão (5 min, 10 min e 15 min) em seis tempos de armazenamento (0, 2, 4, 6 e 8 dias). Nos frutos foram realizadas análises de perda de massa, pH, acidez titulável, sólidos solúveis totais, açúcares redutores e análise sensorial para cor, qualidade geral e incidência de podridões.

Resultados e Discussão: No revestimento que apresentou as melhores condições de conservação das frutas, realizou-se análises microbiológicas para verificar a incidência de Salmonella, Bacillus cereus e Escherichia coli, cujos resultados microbiológicos apresentaram-se dentro do exigido pela legislação vigente. Nas condições do experimento, os revestimentos desenvolvidos apresentaram resultados positivos para a conservação das goiabas, retardando sinais de amadurecimento e aumentando sua vida útil, com destaque para o revestimento composto por 6% de crueira de mandioca e 3% de glicerol, aplicado por 5 minutos, que apresentou melhores características de conservação nas goiabas de maneira geral.

Implicações da Pesquisa: Contribuir na redução de perda pós-colheita de frutas e, consequentemente, impactando na oferta de alimentos de qualidade para a população.

Originalidade/Valor: Reaproveitamento de resíduo gerado na produção de farinha de mandioca, agroindústria de interesse para várias regiões do Pais, na produção de revestimento comestível e natural de baixo custo, que impacta diretamente a conservação de alimentos in natura, diminuindo o desperdício, aumentando a oferta de alimentos, contribuindo assim para segurança alimentar.

Palavras-chave: Crueira de Mandioca, Cobertura de Frutos, Conservação Pós Colheita.

PRODUCCIÓN DE RECUBRIMIENTO COMESTIBLE PARA LA CONSERVACIÓN DE GUAVAJE (Psidium guaiava L) A PARTIR DE RESIDUOS CRUDOS DERIVADOS DE PROCESAMIENTO DE HARINA DE YUCA (Manihot esculenta crantz)

RESUMEN

Objetivo: El presente trabajo tuvo como objetivo utilizar la crueira, residuo del procesamiento de la harina de yuca, para desarrollar un recubrimiento comestible para aplicar a guayabas de la variedad Paluma, con fines de conservación poscosecha.

Marco Teórico: La producción agrícola de la economía brasileña coloca al país en una posición destacada en el escenario internacional, al mismo tiempo que es también referencia en el abastecimiento del mercado interno con productos frescos y sus derivados. Sin embargo, dado el carácter perecedero de los productos, se pierde mucho a lo largo de toda la cadena productiva, y este volumen se incrementa incluso si se considera la generación de residuos derivados del procesamiento de alimentos. Por ejemplo, podemos mencionar la generación de residuos provenientes de la producción de harina de yuca, los cuales tienen sus residuos subutilizados y generalmente dirigidos a una disposición inadecuada, generando impactos ambientales y sociales.

Método: Se probaron diferentes formulaciones utilizando tres variables: yuca cruda (6%, 7% y 8%), glicerol (3%, 4% y 5%), tiempo de inmersión (5 min, 10 min y 15 min) en seis veces (0, 2, 4, 6 y 8 días). A los frutos se les realizaron análisis de pérdida de masa, pH, acidez titulable, sólidos solubles totales, azúcares reductores y análisis sensoriales de color, calidad general e incidencia de pudrición**.**

Resultados y Discusión: En el recubrimiento que presentó mejores condiciones de conservación del fruto se realizaron análisis microbiológicos para verificar la incidencia de Salmonella, Bacillus cereus y Escherichia coli, cuyos resultados microbiológicos estuvieron dentro de los exigidos por la legislación vigente. Bajo las condiciones del experimento, los recubrimientos desarrollados mostraron resultados positivos para la conservación de las guayabas, retrasando signos de maduración y aumentando su vida útil, con énfasis en el recubrimiento compuesto por 6% de yuca crueira y 3% de glicerol, aplicado durante 5 minutos. , que presentó mejores características de conservación en guayabas en general.

Implicaciones de la Investigación: Contribuir a reducir la pérdida poscosecha de frutos y, en consecuencia, impactar en el suministro de alimentos de calidad para la población**.**

Originalidad/Valor: Reutilización de residuos generados en la producción de harina de yuca, agroindustria de interés para varias regiones del país, en la producción de recubrimiento comestible y natural de bajo costo, que impacta directamente en la conservación de alimentos frescos, reduciendo desperdicios, aumentar el suministro de alimentos, contribuyendo así a la seguridad alimentaria.

Palabras clave: Yuca Crueira, Cobertura De Frutos, Conservación Poscosecha.

1 INTRODUCTION

Cassava, in addition to being a food quite versatile and well adapted to different soils and conditions climate , makes up the Brazilian sociocultural scenario , being present us habits food of the various layers social , both in its natural form as processed , with flour being its main derivative consumed .

Done generally in a manner handmade In flour mills, cassava processing generates waste which , in turn , time , routinely , are intended the animal feed or dispose of in a manner undue , causing so , besides possible damages to the quite environment , waste of cargo nutritional that composes such elements . It is valid highlight that cassava , residue liquid he has your application quite discussed within the scope academic , however , for the crueira , residue solid , little is found in the literature about strategies for your use .

According to the National Waste Plan Solids (Planar), the waste organic despite your decomposition capacity , can may present a problem depending on the volume, generation speed and final disposal , being oriented towards replacing the use of landfills with their recycling , with a view to take advantage of the potential maximum of your composition . Added to this , the Organization of the United Nations Food and Agriculture Organization of the United Nations (FAO) , indicates that at the worldwide , about 30% of food produced no they are consumed , wasting like this resources financial and natural imputed to the process productive , in addition to generating more debris to be launched mo quite environment .

There are several stages in the chain productive that impact in the quality of the final product , and changes may be influenced by issues environmental or physiological that result in nonconformities , thus , a time outside the standards commercials , frustrate the consumer expectation , inducing to the disposal . Regarding products of plant origin , breathing post harvest is the main factor responsible for the deterioration , which indicates that the manipulation of the gases entering in contact with the vegetable has impact positive in increasing the term commercial , well as in the preservation of characteristics sensory , in addition to promoting control microbiological .

In this way, the coatings edible they are object of study having in view of your potential conservative while barrier physical , chemical and microbiological , in addition to its nature biodegradable , non-toxic , easy to use production , little interference in the visual aspect and safety for consumption , being compounds basically made up of polysaccharides , lipids , proteins or combinations between them . Some features as availability varied , low cost and ease of handling , make starch object of interest in the research to develop coatings for products of plant origin and also those of animal origin .

In that sense , the destination of the potential nutritional of residues generated in the processing of cassava flour for the preparation of a coating to be applied in vegetables , with the aim of promoting conservation increasing your life useful , translates one proposal with effects positives in the spheres environmental , social , economic and health public .

2 THEORETICAL FRAMEWORK

According to the National Confederation of Industry (2017), Brazil occupies a central position in relation to food supply, leading a multitude of global markets such as the export of processed foods, with the food industry accounting for 23% of the Gross Value of Industrial Production and 9.7% of GDP. The food production sector includes agribusiness, responsible for the processing of raw materials from agriculture, such as meat, coffee and ethanol.

Emerick (2019) states that due to the highly varied composition, depending on the branch of activity, agro-industrial waste has high concentrations of chemical loads, directly affecting biodegradability. This generates additional concern about the final destination of this waste, making it necessary to pre-treat it considering its physical-chemical characteristics in order to reduce its negative effects, thus promoting less aggression to the environment, ultimately increasing production costs.

Solid waste is understood as any element that is discarded by human action in their social activities, and may be in a solid or semi-solid state, gaseous, as long as it is trapped in containers, or even liquid, since its release into the public network is inappropriate due to its characteristics, requiring prior interventions. Once the viability of its use has been exhausted, this material is called waste (BRASIL, 2010).

Law 12.305/2010, which established the National Solid Waste Policy (PNRS), provides guidance on waste management guidelines and the responsibilities of public authorities and individuals, whether individuals or legal entities. The text includes two possibilities for waste: environmentally correct final destination, which prioritizes greater use of all the properties of the waste, and environmentally correct final disposal, which provides guidance on mitigating damage from disposal (BRASIL, 2010).

In this context, Zago and Barros (2019) clarify that it is necessary to establish integrated waste management, promoting actions that encompass the environmental, social, political and economic spheres, with a view to outlining strategies in the search for sustainable development. Both production and consumption of goods and services must be geared towards meeting the needs of current generations without, however, compromising future ones.

It is important to emphasize that all individuals directly involved in the product's life cycle, regardless of the degree of connection or stage in which it is situated, share responsibility for the disposal of waste, its appropriate management with a view to reducing its volume and minimizing impacts on both environmental and human health (ZAGO; BARROS, 2019).

In the order adopted in solid waste management, the priority is non-generation; however, when this is not possible, reduction, reuse, recycling, treatment and environmentally appropriate final disposal of waste follow. The premise that solid waste that can be recycled and reused has economic and social value, promoting empowerment and citizenship, is achieved through the objectives and instruments of the PNRS, which encourages research and development of mechanisms and technologies capable of enabling better reuse (BRASIL, 2010).

However, organic waste was given little priority by the PNRS, compared to the most toxic and environmentally harmful waste, reserving only the right to be directed to the composition of composters and energy use. Likewise, at the state level, Law No. 14,236, of December 13, 2010, and the State Solid Waste Plan address it superficially, indicating composting as a strategy for this waste (PERNAMBUCO, 2010; PERNAMBUCO, 2012).

Faria and Pires (2020) highlight the concept of Circular Economy, which values the optimization of resources, combined with the reduction or elimination of waste, using devalued by-products in processing for allocation to another branch of activity for which the inherent characteristics are relevant, as an alternative for intervention in the scope of the problem of organic waste and its direct relationship with the context of population growth, economy, urbanization, and public health.

Considering the agricultural profile and economic situation of the city of Vitória de Santo Antão, concern is raised about the amount of losses and waste that may occur in the production chain, as well as the destination of waste generated in all its stages, thus culminating in reflection on strategies that can mitigate the impacts on the environment and favor the collective health of the inhabitants.

2.1 CASSAVA AND FLOUR PROCESSING

Scientific name Manihot esculenta Crantz and originating in South America, cassava was already a very popular crop among native Indians before European colonization, even starring in folk legends about its origin. The settlement and exploration of the lands then allowed the exchange and intercontinental dissemination of this crop, mainly to the territories of Africa and Asia (NASSAR, 2006).

Categorized in the Euphorbiaceae family, it is classified as a heliophilous plant due to its need for exposure to sunlight, perennial given its long life cycle and shrubby, since its stem has branches from the base. Its easy adaptation to climatic conditions allows cultivation from dry to low temperature environments, however , sandy or flooded soils are not suitable for the development of its main part, the root (EMBRAPA, 2006; CRUZ, 2017).

In addition, Alves et al. (2019) point out that harvesting can be carried out mechanically, but manual techniques are predominant, in which the branches are pruned and the stems are selected for the cuttings that will be used in the next planting. Finally, the roots are extracted from the soil. It is important to emphasize that despite its versatility, the optimal harvest point should be defined based on the intended use of the final product, with cassava for human consumption being suitable between 8 and 14 months, while cassava for processing is suitable between 14 and 24 months.

Regarding nutritional characteristics, according to the Brazilian Food Composition Table, raw cassava roots have in their composition carbohydrates, proteins, lipids, fibers, calcium, magnesium, manganese, phosphorus, iron, sodium, potassium, copper, zinc, vitamin B6 and vitamin C. A source of complex carbohydrates, it has a low glycemic index, which allows slow absorption and digestion of glucose, ensuring greater satiety (UNICAMP, 2011).

In addition, Oliveira et al. (2021) warn that the hydrocyanic acid (HCN) present in the composition of cassava is toxic, and in large quantities it can be fatal, which makes its concentration a factor in classifying the roots, which are popularly known as sweet/table or bitter/wild, according to the acid content. For table cassava, yuca or cassava, indicated for human and animal consumption, the value should not exceed 50 mg of HCN per kilogram of root; above these values, cassava
is called brave. Due to the release of HCN during the processing of the roots, both types can be used by the industry.

Regarding production terms, according to IBGE (2022), Brazil has cassava crops in the most different regions, and the 2020 production figures indicate the Northeast region as responsible for 20.94% of the national total, with Pará being the main national producer, followed by Paraná, São Paulo and Amazonas, while the state of Pernambuco, with a production of 484,516 tons, is ranked 13th in the ranking, and 4th regionally, behind Bahia, Ceará and Alagoas, respectively, as can be seen in Table 1.

Table 1

Cassava Production in Brazil and Regions of the Federation - 2020 Harvest

Production of M	**andioca - 2020 Harvest (Tons)**
Brazil	18,955,430
North	6,700,952
To	3,813,154
Amazonas	1,239,598
Acre	600.363
Rondônia	519,582
Roraima	178,859
Amapá	112,663
South	4,589,732
Paraná	3,463,500
Rio Grande do Sul	791.96
Santa Catarina	334,272
North East	3,971,369
Bahia	963,000
Ceara	641.211
Alagoas	535,365
Pernambuco	484,516
Piauí	444,433

Maranhao	412,422
Tocantins	236,733
Rio Grande do Norte	201,474
Sergipe	151,739
Paraiba	137.209
Southeast	2,283,232
São Paulo	1,484,885
Minas Gerais	519,764
Rio de Janeiro	151.018
Holy Spirit	127,565
Midwest	1,410,145
Mato Grosso do Sul	946,968
Mato Grosso	275,026
Goias	168,631
Federal District	19,520

Table 2 presents data on cassava production in the state of Pernambuco in 2020, emphasizing the subdivision into the Sertão, Agreste, Mata, Metropolitan Region and São Francisco regions, with emphasis on the city of Vitória de Santo Antão, the project execution area (IBGE, 2022).

Table 2

Cassava Production in 2020 – Pernambuco

Cassava Production in Pernambuc	o – 2020 (Tons)
Brazil	18.205.120
Pernambuco	433,938
Pernambuco Backlands	169,692
Pernambuco Countryside	191,024
Pernambuco Forest	41,636
Victory of Santo Antao	2,700
Metropolitan of Recife	21,546
Saint Francis of Pernambuco	10.040

Declared by the UN as the most relevant food of the 21st century, cassava has great potential for transformation into food items due to its high starch content , which allows the harvest to be destined for agro-industrial processing. More than its nutritional importance, it is consolidated as part of the sociocultural context of farmers who, in the Northeast, process the roots in family flour mills. Its most commonly produced derivatives are flour and starch, with most of the harvest destined for flour production (EMBRAPA, 2017; SENAR, 2018).

Artisanal flour processing does not require high-tech equipment and follows the flow of the following steps: reception, peeling and washing by abrasion, crushing the roots, pressing the dough, sifting (optional), crumbling, roasting, sifting, packaging and storage, with waste generated throughout the chain that will later be discarded into the environment without prior treatment (SOUZA; FIALHO, 2003; ARAÚJO, 2008; Martinez; Feiden , 2017).

From this perspective, Martinez and Feiden (2017) point out that in the washing and peeling stage, to avoid damaging the equipment, the peels are removed and with them, soil and inner bark, where fragments of roots with great nutritional diversity are also lost, which are composed of great nutritional diversity. During sieving, pieces of fibers and inner bark are retained and discarded, not participating in the roasting process. This residue is called crueira .

Liquid waste is also generated in the process of washing the roots and pressing the crushed mass , the first being capable of recirculation, and the second, called manipueira , is rich in organic matter, nutrients and compounds, including cyanide.

However, Silva (2015) emphasizes that despite some possible applications such as animal feed, fertilizers and pesticides, there is no standard adopted for the destination of cassava flour processing waste, which often ends up being discarded into nature without prior treatment, resulting in damage to the environment. It is important to highlight the presence of hydrocyanic acid in its composition, which makes it toxic, which draws attention to the risk of disposing of it into the environment without prior treatment, which may contaminate soil and groundwater.

The need for environmental management of these residues is thus clear, with a view to making better use of the nutrients available in the roots, as well as mitigating environmental damage. Araújo (2014) emphasizes that at a domestic level, the generation of residues from the use of cassava is not significant; however, the industrialization of the root causes environmental problems, since the inadequate disposal of by-products can constitute an aggression to the environment. Linked to this, the authors weigh the aspect of waste of yield when considering the quality and quantity of the discarded material.

Due to its prominence as the most abundant residue from flour processing, there are many studies that indicate the possibility of directing cassava flour , with a view to avoiding environmental contamination. Thus, the widespread exploitation of this residue for use as soil fertilizer, pesticide in agriculture, and even as an input for the production of vinegar, bricks and soap, already establishes opportunities for reuse, information data not observed in relation to other residues (SEBRAE, 2014).

Wosiacki and Cereda (2002) state that one of the strategies for using fibrous residue consists of drying it in ovens, a process similar to that used for flour, resulting in a product called farinhão . However, the high operational costs of this processing do not justify its effectiveness as a reuse, since its exclusive destination is for animal feed.

2.2 FOOD INSECURITY AND FOOD WASTE

Food and nutritional insecurity is understood as the failure to realize the right to regular and permanent access to quality food in sufficient quantity. Achieving food security must not compromise the guarantee of other basic needs, and its establishment must occur in an intersectoral and participatory manner, respecting the environmental, social, economic and cultural diversity of the populations (MACHADO, 2017).

Castro (2019) emphasizes that public policies must be designed to urgently reverse situations of food insecurity. However, setbacks are frequent, as occurred in Brazil in 2019 with the extinction of the National Council for Food and Nutrition Security (CONSEA), an agency that was part of the National Food and Nutrition Security System (SISAN), and which was a stage for intersectoral debates on issues related to topics such as school meals, family farming and the fight against hunger.

The Universal Declaration of Human Rights of 1948, provides in its article 25: “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services (...)” (UNICEF, art. 25, 2019).

Despite such sovereignty, Conti (2014) shows that it was only through social mobilizations that the right to food was formally recognized and included in Article 6 of the Brazilian Constitution, through Constitutional Amendment No. 64, strengthening the fight against food insecurity throughout the national territory.

According to Rodrigues (2019), hunger can be translated as the need to eat, for nutritional replacement by the body, but, despite a very simple definition, there are several factors that can cause this sensation, whether physiological or psychological. Thus, the search for food can be carried out by sensory stimuli or mechanisms of the body itself to maintain its activities.

On the other hand, excessive food intake leads to the accumulation of nutrients that the body does not use in its functions, and these end up being stored and causing overweight and obesity. The opposite also occurs, in the absence of nutritional reserves, reserves are used to maintain bodily activities, first consuming glucose reserves, followed by fats and finally proteins. All of these nutritional categories have specific physiological importance, so in the event of a deficit, development and vital functions may be compromised (ZAIA; BORTNOWSKA, 2019).

Philipi (2014) indicates that foods are separated into groups according to their function, namely: energy foods, which include carbohydrates, which are responsible for providing energy for daily activities; building foods, represented by proteins, which act in the formation of all structures; and regulatory foods, where vitamins predominate, which allow the body to function. Another category is that of extra-energy foods, which contain lipids and sugars, which have a high calorie content.

In this sense, feeding transcends the concept of eating by requiring the establishment of a link between quality and quantity. More than just intake, the criteria of adequacy and variety must be taken into consideration, considering that organisms are different and, therefore, have different needs for their maintenance, despite the indispensability of the presence of general categories of macro and micronutrients that must be standards (BRASIL, 2014).

The causes that impact food security can be very diverse, from climate change, territorial conflicts, politics, and economic downturn. The global hunger panorama reveals that, although at a slower pace, the number of people who do not have access to decent, quality food continues to follow the upward trend observed since 2014. Statistics from 2019 showed that 690 million people, representing 8.9% of the entire population, are undernourished, 10 million more than in the previous year, 2018 (FAO, 2020).

This situation was greatly aggravated by the emergence of the SARS-CoV-2 pandemic, which has generated uncertainty and made it difficult to predict trends in both food supply and demand since its emergence. Projections indicate that the pandemic affected the food security of around 83 to 132 million people in 2020, in addition to those already included in the statistics (FAO, 2020).

Research indicates that the global average of the population in a state of malnutrition is currently 8.9%, however, geographically, there are small percentage differences in this distribution between the most affected continents. While in Africa, at the top of the list, an estimated 19.1% of the population is undernourished, the prevalence in Asia is 8.3%, and in Latin America and the Caribbean it is 7.4% (FAO, 2020).

In 2015, the United Nations established 17 Sustainable Development Goals (SDGs) to address global development and improve quality of life, calling for collective efforts from all levels of society. Of particular note here is SDG 2, which addresses the eradication of hunger, access to safe food and fostering sustainable and resilient production, and SDG 12, which calls for sustainable management and efficient use of natural resources, in addition to halving per capita food waste worldwide (UN, 2015).

Contrary to such ideals, Santos (2020) emphasizes that food losses and waste still present significant numbers across the planet, impacting the global economy, the population and the environment, reducing the availability of food as well as the income of producers, increasing prices and the depletion of natural resources, reflecting the insufficiency of public policies, society's efforts and production systems, constituting one of the major obstacles to achieving food security.

According to FAO (2020), while more than 820 million people in the world are still facing hunger, it is estimated that around 14% of food is lost throughout the production chain. Porpino et al. (2018) in their research revealed that the foods most wasted by consumers were: rice (22%), beef (20%), beans (16%), chicken (15%), vegetables (4%) and fruits (4%).

However, Zaro (2018) emphasizes that it is essential to highlight the existence of different concepts for loss and waste. While the first is more intrinsic to the technological issue and the lack of investments to mitigate damages, the second concerns the behavioral patterns of consumers influenced by the entire sociocultural context in which these actors are inserted.

The concept of loss encompasses involuntary and unplanned acts, and although it encompasses products that do not reach the consumer, their production costs are passed on to the final value of the goods, indirectly burdening the consumer. Prevalent in developing countries, the main factors that generate losses are weather conditions, incorrect handling throughout the production chain and inefficient packaging (CAISAN, 2018; FAO, 2019).

In turn, waste is voluntary, more visible and, therefore, more moving, being more evident in developed countries, occurring at the end of the chain due to the mistaken actions of consumers in homes and commercial establishments when generating leftovers or problems such as inadequate storage, expired validity and lack of awareness. Castro and Oliveira (2017) state that 60% of the waste discarded in Brazil corresponds to organic waste that will not be subsequently recycled (ZARO, 2018).

Food quality is quite subjective, being based on the consumer's expectations regarding the characteristics of each product. However, as a way of standardizing marketing, the Ministry of Agriculture, through Normative Instruction No. 69 of 2018, defines the minimum requirements for quality and identity of horticultural products, emphasizing characteristics that must be present in general:

Art. 5. Vegetables must meet the following minimum quality requirements, taking into account the specificity of the species:

I - integers ;

II - clean ;

III- firm;

IV- free from pests visible to the naked eye;

V- physiologically developed or showing commercial maturity; VI - free from strange odors;

VII - they are not excessively ripe or past their prime; VIII - free from deep damage;

IX- free from rot;

X- they are not dehydrated or withered; XI - they are not presented frozen; and

XII - free from physiological disorders (BRAZIL, art. 5, 2018).

The 2017-2018 Household Budget Survey (POF) showed that in Brazilian households the annual acquisition of fruit was around 26.41 kg per capita. However, depending on the household situation, differences were revealed, where the urban population accounted for 27.69 kg of fruit per capita in contrast to 19.02 kg in rural households acquired in the period studied (IBGE, 2019).

According to the POF, it was observed that the acquisition of fruits fluctuated between economic classes, and it was notable that the higher the purchasing power of the household, the greater the volume of fruits acquired. This data leads to reflection on the causes associated with this disparity. Oliveira et al. (2020) lists the income of individuals, the cost of such foods, difficulties in access and deficiencies in public policies (IBGE, 2019).

In the quest to meet the SDGs and support small farmers, the UN General Assembly named 2021 the International Year of Fruits and Vegetables, thus, led by FAO, it focused its efforts on disseminating information about the health benefits associated with the consumption of fruits and vegetables, and on reducing their waste (FAO, 2020).

Given this, investments in food coatings can greatly contribute to reducing this waste.

2.3 FOOD COATINGS

The Ministry of Health, through Collegiate Board Resolution 259 of September 20, 2002 (RDC 259/02), defines the term food as any element suitable for human consumption, whether the final product is presented in its natural state, minimally processed or processed, which includes beverages and any additives necessary for preparation or treatment (BRASIL, 2002).

To the consumer, food, whether whole, fractionated or processed, is generally offered packaged. Regarding packaging, the legislation defines it as any container or wrapper that is intended to guarantee conservation or facilitate transportation and handling, and may be primary, if in direct contact with the food, secondary or tertiary, indicating the subsequent layers of protection (BRASIL, 2002).

In this way, packaging constitutes a barrier protecting the product contained within it from external agents, contamination, adulteration and also changes that may be caused at all stages of its production chain until it reaches the final consumer. Thus, until the packaging is violated, all the characteristics inherent to the food and indicated on its labeling must be preserved while its expiration date is in effect (BRASIL, 2001).

Both packaging and equipment that come into direct contact with food, whether during processing or distribution, must have characteristics that ensure compliance with good manufacturing practices, so that they do not pose risks to consumer health or produce undesirable changes in composition or sensory properties (BRASIL, 2001; SOUZA; MOURA; SILVA, 2017).

To this end, such elements must be composed of non-toxic materials, free of contaminants and their interaction with the food must not result in migration of components above the established maximum limits. Thus, tests must be reproduced in order to ensure that the constituents of all material to which the food is exposed meet the requirements established by law (BRASIL, 2001; JORGE, 2013).

However, Lima et al. (2018) emphasize that not all interactions between food and packaging are condemned or reflect negligence; some are programmed to occur voluntarily and contribute to the preservation and maintenance of their safety, especially in products of plant origin. This category is represented by the technologies present in active and intelligent packaging.

“Active” packaging is defined as packaging that, in addition to its general functions, alters the environmental conditions around the food, aiming to preserve its sensory properties, ensuring that the food remains safe and, in this way, extending its shelf life while confined. It includes the entire group of packaging where elements have been added to its formulation or to the available empty space to enhance its conservation effectiveness (SUHAG et al., 2020; ANTONIOLLI, 2015).

Sarantópoulos and Cofcewicz (2016) draw attention to the problem of vegetable packaging with regard to the respiration rate. Ethylene is a natural product of plant metabolism that acts directly on the ripening process. As its concentration in the packaging atmosphere increases, it promotes an increase in the respiratory rate of the fruits, accelerating their senescence. Therefore, the use of ethylene absorbers is one of the approaches to the practice of active packaging.

Another major concern is moisture loss, which can be caused by breathing, perspiration or microbial activity. Temperature changes cause water vapor to condense on the surface of the vegetable or on the inside of the packaging, allowing microorganisms to proliferate and interfering with the aesthetics of the final product. To this end, the use of water vapor adsorbents is another resource incorporated into the active packaging system (NOLÊTTO, 2018).

Still within the approach to vegetable conservation, Nolêtto and Loureiro (2016) state that smart packaging, in turn, differs in that it allows the capture and identification of variables that affect the food, presenting the real conditions in which they are found. It is possible to monitor pH, relative humidity, temperature, gas composition and other parameters, allowing logistical control to mitigate impacts, however, these technologies are still expensive.

As examples that fall into this category, Casanova et al. (2020) cite time-temperature indicator systems. Exposure to high temperatures and its consequent cumulative effects are recorded by the irreversible activation of indicators of chemical, electrochemical, physical, microbiological or enzymatic origin, which are visually displayed on devices fixed to the outside, allowing the handler to read them.

Visual color characteristics are the main indicators that fruits have undergone the ripening process and are suitable for consumption. However, not all fruits present such changes, and, added to the contact restriction caused by packaging , consumers encounter difficulties in the acquisition process. Packaging equipped with ripening sensors activated by volatile compounds released during ripening is another strategy for innovation and attribution of intelligence (SARANTÓPOULOS; COFCEWICZ, 2016).

Considering the costs of these technologies, modified atmosphere is an affordable strategy, a widely reproduced technique for preserving vegetables. However, the use of disposable material is also an activity that generates environmental impact given the volume of packaging waste that is generated. In this context, the use of edible coatings is a conservation device by forming a film adhered to surfaces, constituting a barrier that reduces gas exchange, while also being biodegradable and transparent in color, without interfering with their visual characteristics (ARAUJO, 2014; GOMES et al, 2016).

No specific legislation was found by the National Health Surveillance Agency (ANVISA) that regulates the issue of coatings, and they can be classified as ingredients, when their properties alter the composition of the product, or additive, with no modification of the composition of the nutritional aspect. Among the characteristics necessary for its successful development, it is required that it be free of toxic and allergenic components, present good adhesion to the surface, in addition to the economic and technological viability for its production (MACHADO, 2020).

Assessed as low-cost and with a simplified methodology, the use of such coatings is consolidated as an easily replicable practice , including in the sphere of small farmers and food processors. In addition, studies have shown their efficiency not only in whole or minimally processed plant-based foods, but also satisfactory for meat, eggs and cheeses (PIRES, 2019; SANTOS, 2019; AMANCIO, 2020; MONÇÃO, 2020).

In this sense, Silva et al. (2016) refer to starch as an important raw material for the production of films given its already consolidated attributes in mechanical and sensory characteristics, providing protection without interfering with the visual aspect. In addition, the low cost and wide availability of sources allow such techniques to be widely disseminated and reproduced. The addition of plasticizers to the coating solution provides even better mechanical performance, directly interfering with its flexibility. Menezes et al. (2018) studied the use of films based on cassava starch, cornstarch, calcium chloride and propolis extract in table tomatoes, obtaining good results in the parameters of firmness, skin color, general quality and incidence of rot, as well as sensory parameters in all tests, with emphasis on starch-based coatings.

2.4 GUAVA: GENERAL CONSIDERATIONS

Scientific name Psidium guajava L., guava is native to South America, but its culture was spread across the continents by European navigators thanks to its wide adaptability. Its great availability and wide acceptance promotes its consumption in natura, but there is also a large quantity of derivatives, including juices, sweets, sauces (CASTRO; RIBEIRO, 2020).

Despite its origin, the guava tree is easy to grow due to its adaptability and propagation by seed, and is present in many different regions of the world. The plant grows and produces well at altitudes of up to 1,700 m, has an ideal temperature range of 25 to 30 °C and humidity between 50 and 80%. As for soil, it adapts best to sandy and clayey soils rich in organic matter and with a slightly acidic pH, between 5.0 and 6.5 (GONZAGA NETO, 2007).

Also according to IBGE (2022), national guava production in 2020 reached 566,293 tons, a scenario in which the northeast region was the largest producer of the fruit, with 284,503 tons, with the state of Pernambuco standing out as responsible for 206,259 tons, being considered the largest national producer in that year (Table 3).

Table 3

National guava production – 2020 Harvest

Location	Quantity (tons)
Brazil	566,293
North East	284,503
Pernambuco	206.259
Southeast	232.023
South	30,855
Midwest	12.703
North	6.209

Data from the Ministry of Agriculture, Livestock and Supply (2021) indicate that the guava export market has fluctuated over the last decade, as can be seen in Table 4, resuming the growth trend from 2018 onwards. The scenario reveals great expectations for 2022.

Table 4

Guava Export Data

Guava Export Data	
Year	Weight (kg)
2011	137,455
2012	119,705
2013	143,945
2014	170,776
2015	203,936
2016	172,099
2017	142,691
2018	166,700
2019	198,222
2020	237,993
2021	450,636

From a physiological point of view, as it is a climacteric fruit, at the end of the ripening period there is an increase in the respiratory rate and ethylene production, which allows harvesting to occur with the fruits still green, in order to facilitate handling and contribute to the conservation process, since the fruit continues to ripen even after being separated from the mother plant. It is estimated that at room temperature, guava ripening occurs in approximately 3 to 5 days (BARBOSA and LIMA, 2010).

Regarding nutritional properties, the food composition table indicates that 100g of red guava has a caloric load of 54kcal, 1.1g of protein, 0.4g of lipids, 13g of carbohydrates, 6.2g of dietary fiber and 80.6mg of vitamin C, a value higher than that found in citrus fruits such as lemon, which contains 47.6mg, orange , with 53.7mg and pineapple with 34.6mg. In addition, it is a source of group B vitamins, and contains significant levels of vitamin A, phosphorus, potassium and calcium (UNICAMP, 2011).

Given everything that has been presented, given the importance of fruit farming in the composition of the Brazilian GDP, issues related to food security, combating hunger, and food waste, the development of a food coating derived from the use of waste is configured as an important transversal strategy for mitigating the damage associated with problems that are deep-rooted, encompassing economic, social and environmental aspects.

3 METHODOLOGY

For the present study, guavas harvested from an institutional orchard were used. being from the variety Palm us treatments witness and essays of 1 the 11. Purchased from a local producer, who uses calcium fertilization before and after flowering in order to increase the resistance of the skin. Guavas with standardized ripening stages were selected, and those with green skin coloration and no injuries or deterioration of microbiological origin were accepted. Analysis of mass loss, pH, titratable acidity , solids soluble totals, sugars reducers and analysis sensory to color, general quality and incidence of rot. On the coating that presented the best conditions for preserving the fruits, analyses were carried out microbiological to check the incidence of Salmonella, Bacillus cereus and Escherichia coli. To verify the feasibility of producing the coating, an analysis of the resources involved in the production process was carried out.

4 RESULTS AND DISCUSSIONS

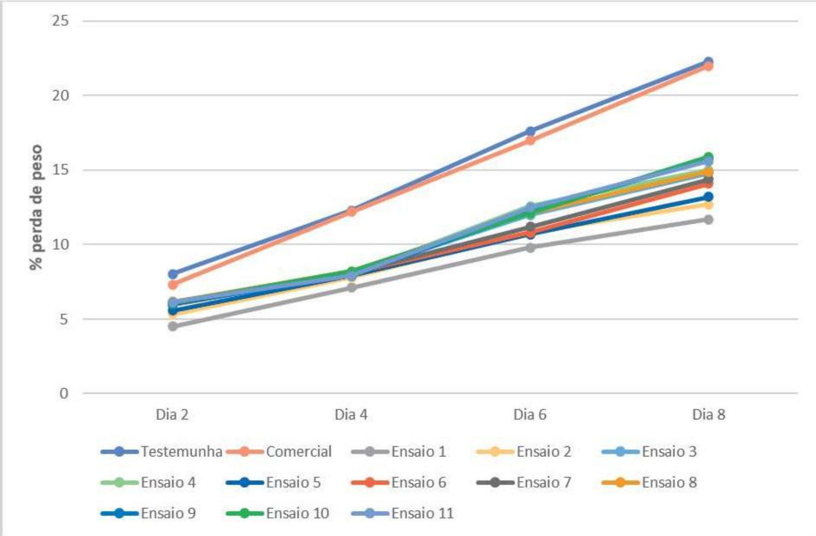
4.1 COMPOSITION OF THE FRUITS

4.1.1 Loss of mass

Figure 1 reveals the performance of the fruits with regard to loss of mass. In general, weight loss occurred in all treatments and was observed on all days of analysis, with trials 1 and 2 accounting for the lowest percentages in relation to the others, while the control and commercial trials were those that suffered the most from this variation, presenting values greater than 20%.

Figure 1

Variation of percentage of loss of mass of the fruits of guava stored at room temperature and different treatments over the storage time



Witness: without coating; Commercial: without coating, acquired node market local; Rehearsal 1: 6% crueira , 3% glycerol, 5 min; Trial 2: 8% crueira , 3 % glycerol, 5 min; Trial 3: 6% crueira , 5% glycerol, 5 min; Rehearsal 4: 8% of cruciate , 5% of glycerol, 5 min; Rehearsal 5: 6% of cruciate , 3% of glycerol, 15 min; Rehearsal 6: 8% of cruciate , 3% of glycerol, 15 min; Rehearsal 7: 6% of cruciate , 5% of glycerol, 15 min; Essay 8: 8% of cruciate , 5% of glycerol, 15 min; Rehearsal 9: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 10: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 11: 7% of cruciate , 4% of glycerol, 10 min. Source: the author (2022).

With the exception of treatments 9, 10 and 11, all of them presented losses of weight. maximum 15% of your mass initial, values similar to the found put Ribeiro *et al.* (2005) in wax-coated guavas of carnauba kept at room temperature and within the quality limits indicated by Manica *et al.* (2000). THE The importance of this result lies in the way the fruits are sold, in terms of weight.

It was found that the tested coating ensured less weight loss in all you treatments, in accordance with Lopes *et al.* (2018) what also found decreasing results of mass loss in guavas coated with starch added with casein and barbatimão, reiterating the role of the coating as a physical barrier, being capable of modifying the atmosphere and inhibiting gas exchange.

For Garcia *et al.* (2021), the main function of coatings is to control water loss from fruits, reducing the loss of mass that occurs during storage. The authors consider that an obvious implication is the softening of tissues, which, in addition to affecting sensory characteristics, increases exposure to deterioration.

In this sense, Rodrigues *et al.* (2020) reinforce that mass loss is directly influenced by water loss, being a respiratory metabolic reaction that occurs in the post harvest and ends put interfere in the quality from the guava. state that storage temperature has a decisive influence on loss of mass, with high temperatures being responsible for greater transpiration in the fruits and, consequently, acceleration in the senescence process, a situation that is delayed if they are kept refrigerated.

In general, percentage decreases of between 10 and 20% in the mass of guavas observed up to 8 days after harvesting are considered normal reductions, according to Rodrigues *et al.* (2020), but they cause some problems that manifest themselves both in visual changes, caused by the dehydrated appearance, and in terms of texture, since it deviates from what the consumer expects when purchasing such a product.

Alves *et al.* (2011) when studying the application of different types of starch in the conservation of strawberries, reported the efficiency of cassava starch compared to others in the maintenance of weight of strawberries. Of form similar, Menezes *et al.* (2017), When testing different types of starch in preserving table tomatoes, they obtained the lowest percentages at the end of the experiment.

4.1.2 pH

The results of the experiment indicate that for coated and uncoated fruits, in general, the pH remained on an increasing trend throughout the experiment and in all tests, except for some small fluctuations during the period. of storage, corroborating with Pear tree (2018) what also no found significant differences in pH when studying the behavior of different genotypes of packaged and unpackaged guavas, stored at 20ºC.

Oliveira *et al.* (2017) relates the increase in pH to the consumption of organic acids resulting from the maturation process, associating the two variables as inversely proportional. However, it is inferred from Chitarra and Chitarra (2005) that the slight oscillation in pH is associated with the control exercised by organic acids and salts that end up acting as a kind of buffer, preventing significant variation. This concept had already been cited by Fakhouri and Grosso (2003) who report that the buffering effect due to the presence of organic acids and their salts prevents that the increase in Total titratable acidity significantly alters pH.

4.1.3 Acidity titratable of the fruits

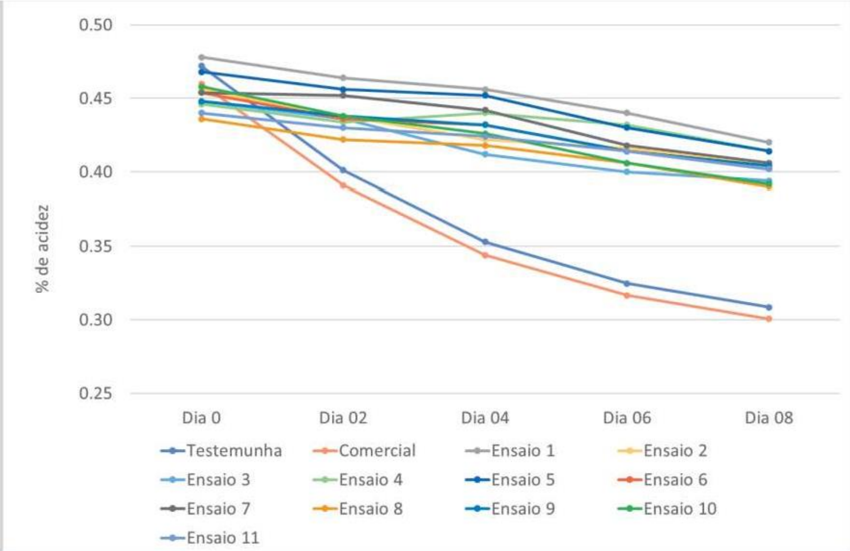
In all treatments, there was a noticeable decrease in acidity during the period in which the guavas remained stored, with initial acidity between 0.43% and 0.47%, ending the analysis period between 0.30 and 0.42%. These results corroborate Mercado-Silva *et al* .

(1998), Oliveira and Cereda (1999), Jacomino *et al* . (2003) and Ribeiro *et al.* (2005), who also reported a decrease in fruit acidity during storage.

It can be inferred from the Figure 2 that the film formed under the coated fruits was able to reduce their respiratory activity while preserving the organic acid content, a similar response was obtained by Oliveira *et al.* (2017) who coated guavas with cassava starch, Menezes *et al.* (2017), when observing the behavior of table tomatoes coated with cassava starch, Soares *et al.* (2011), when analyzing cassava-based coatings added with acetic acid or chitosan in the preservation of guavas and Oliveira and Cereda (2003) who studied post-harvest peaches coated with starches.

Figure 2

Variation from the acidity of the fruits of guava stored the temperature environment and different treatments throughout the storage time



Witness: without coating; Commercial: without coating, acquired node market local; Rehearsal 1: 6% crueira , 3% glycerol, 5 min; Trial 2: 8% crueira , 3% glycerol , 5 min; Trial 3: 6% crueira , 5% glycerol, 5 min; Rehearsal 4: 8% of cruciate , 5% of glycerol, 5 min; Rehearsal 5: 6% of cruciate , 3% of glycerol, 15 min; Rehearsal 6: 8% of cruciate , 3% of glycerol, 15 min; Rehearsal 7: 6% of cruciate , 5% of glycerol, 15 min; Essay 8: 8% of cruciate , 5% of glycerol, 15 min; Rehearsal 9: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 10: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 11: 7% of cruciate , 4% of glycerol, 10 min. Source: the author (2022).

Chitarra and Chitarra (2005) attribute the acidity values to the presence of organic acids that vary between species of the same fruit, with citric acid being predominant in guava. For the authors, the reduction in acidity can be explained by the process of maturation accomplished for the transformation of the acids organic in sugars and used by cells in the respiratory process.

For Francisco *et al.* (2020), who analyzed the shelf life of guavas with starch and cellulose-based coatings, the decrease in ATT during the study is related to the hydrolysis of pectin, which is responsible for the release of galacturonic acid and production of organic acids by glycolysis, accompanied by the hydrolysis of acids carried out through aerobic cellular respiration.

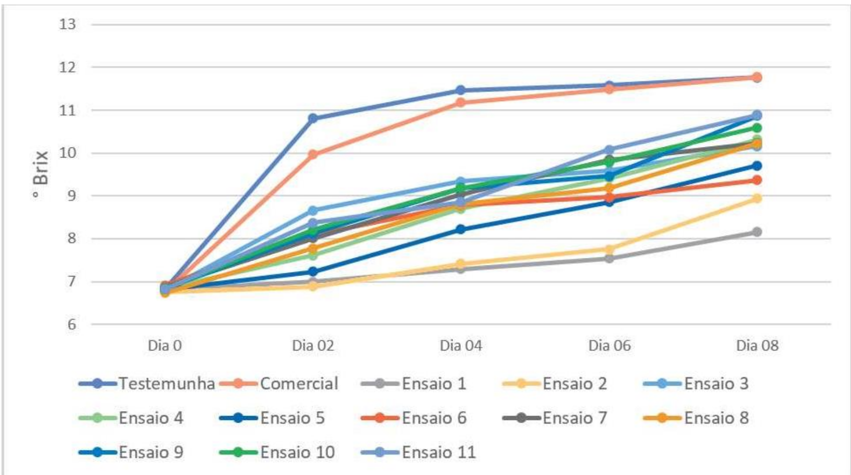
4.1.4 Solids soluble totals

The values of total soluble solids showed a statistically significant difference between the witness and rehearsal 1, during the period of analysis. From agreement with Silva (2021), after harvesting, the soluble solids content of guava undergoes changes that are not significant due to the low starch content in their composition, which is around 1 to 3%, and this parameter is affected by factors that alter fructose synthesis. In fruits that have high starch values in their composition, there is a significant increase in the TSS content during ripening.

In Figure 3, it was possible to observe a slight increase in the TSS content in all treatments, being more evident in the control and commercial treatments. According to Lopes *et al.* (2018), it is possible that the tests that did not receive coating presented higher TSS contents than the others due to a greater loss of mass, which ends up concentrating substances such as sugars and organic acids. Martins *et al.* (2021) confirm and add that the increase in the TSS content also occurs due to the degradation of cell wall polysaccharides.

Figure 3

Values medium to solids soluble totals and Detour standard of coated and uncoated guavas, stored at 27ºC for 8 days.



Witness: without coating; Commercial: without coating, acquired node market local; Rehearsal 1: 6% crueira , 3% glycerol, 5 min; Trial 2: 8% crueira , 3% glycerol , 5 min; Trial 3: 6% crueira , 5% glycerol, 5 min; Rehearsal

4: 8% of cruciate , 5% of glycerol, 5 min; Rehearsal 5: 6% of cruciate , 3% of glycerol, 15 min; Rehearsal 6: 8% of cruciate , 3% of glycerol, 15 min; Rehearsal 7: 6% of cruciate , 5% of glycerol, 15 min; Essay 8: 8% of cruciate , 5% of glycerol, 15 min; Rehearsal 9: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 10: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 11: 7% of cruciate , 4% of glycerol, 10 min. Source: the author (2022).

The authors also emphasize that the parameter in question concerns the ripening of the fruits, and therefore, the lower variation in TSS in those coated is associated with slower ripening. In addition, Quirino *et al.* (2018), when studying guavas coated with cassava starch and pectin, also obtained lower TSS values compared to those that did not receive the treatment.

Menezes *et al.* (2017) also observed a delay in the ripening process of tomatoes coated with cassava starch, presenting more efficient than other types tested in the aforementioned study, including cornstarch. Similarly, Moreira *et al.* (2017) also found lower sugar levels in peppers coated with cassava starch, compared to the control.

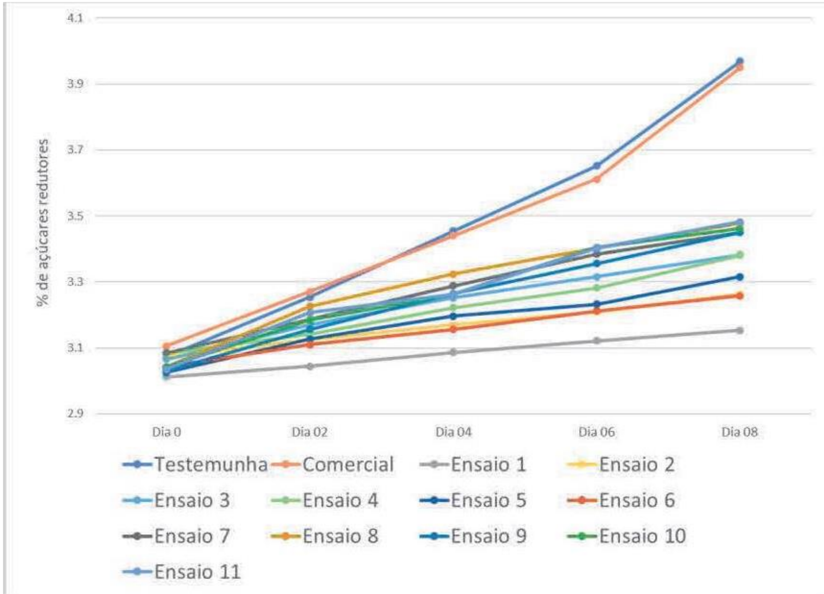
It is worth highlighting the statement by Chitarra and Chitarra (2005) that, although the TSS content is directly related to the sugar content of the fruit, this parameter It also takes into account other substances such as organic acids. Thus, Cavalini (2004) reaffirms the importance of soluble solids and acidity levels due to the impacts on the sensory characteristics of the fruits.

4.1.5 Sugars reducers

Figure 4 shows the variation in the reducing sugar content during the experiment. AND possible to verify what you values if showed increasing the driving of the tests, in addition, it is observed that the guavas that were not subjected to the treatments presented higher values at the end of the analysis period. Martins *et al.* (2021) attribute this event to a slower ripening process that occurred in the coated guavas, given a decrease in the hydrolysis process of polysaccharides, hemicellulose and pectic substances in the cell wall.

Figure 4

Values medium to sugars reducers and Detour standard of guavas coated and uncoated, stored at 27ºC for 8 days



Witness: without coating; Commercial: without coating, acquired node market local; Rehearsal 1: 6% crueira , 3% glycerol, 5 min; Trial 2: 8% crueira , 3% glycerol , 5 min; Trial 3: 6% crueira , 5% glycerol, 5 min; Rehearsal 4: 8% of cruciate , 5% of glycerol, 5 min; Rehearsal 5: 6% of cruciate , 3% of glycerol, 15 min; Rehearsal 6: 8% of cruciate , 3% of glycerol, 15 min; Rehearsal 7: 6% of cruciate , 5% of glycerol, 15 min; Essay 8: 8% of cruciate , 5% of glycerol, 15 min; Rehearsal 9: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 10: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 11: 7% of cruciate , 4% of glycerol, 10 min. Source: the author (2022)

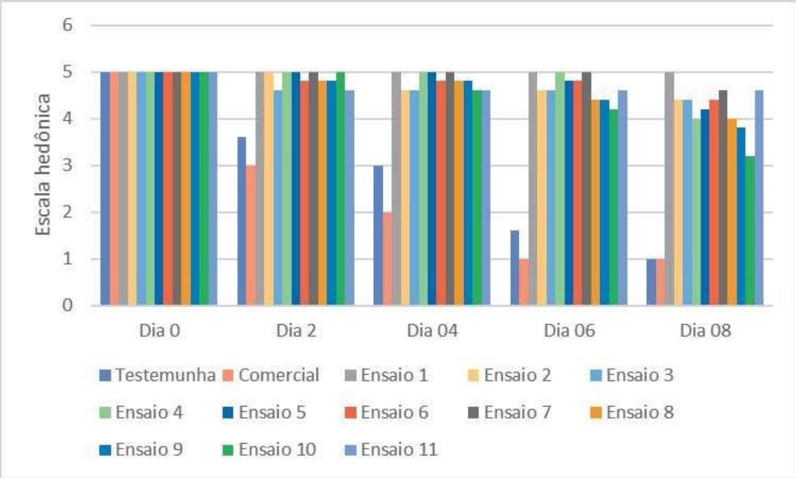
Vila *et al.* (2007) reported a linear increase in the reducing sugar content of Pedro Sato guavas coated with cassava starch biofilm and stored under refrigeration. The authors highlighted the better performance of the combination of temperature and modification of the atmosphere of the fruits in delaying the increase in the levels of reducing sugars, which are altered due to the conversion of complex carbohydrates into monosaccharides, maturation or effects caused by the environment, such as water loss.

4.1.6 Evaluation sensory

Figure 5 shows the evolution of the guavas' appearance throughout the experiment. From the second day onwards, a similar behavior can be seen among the fruits that were not coated, where both the control and the commercial ones show a more yellowish coloration, indicating that the loss of pigment occurred more quickly in these groups of fruits. In contrast, the coated guavas maintained their green coloration throughout most of the study, showing signs of change only from day 6 onwards, as can be seen in Figures 5 to 7 .

Figure 5

Assessment of color from the bark of the guavas



Scale hedonic - 5: Green dark; 4: Green; 3: Green yellow; 2: 50% yellow; 1: Yellow .
Witness: without coating; Commercial: without coating, acquired node market local; Rehearsal 1: 6% crueira , 3% glycerol, 5 min; Trial 2: 8% crueira , 3% glycerol , 5 min; Trial 3: 6% crueira , 5% glycerol, 5 min; Rehearsal 4: 8% of cruciate , 5% of glycerol, 5 min; Rehearsal 5: 6% of cruciate , 3% of glycerol, 15 min; Rehearsal 6: 8% of cruciate , 3% of glycerol, 15 min; Rehearsal 7: 6% of cruciate , 5% of glycerol, 15 min; Essay 8: 8% of cruciate , 5% of glycerol, 15 min; Rehearsal 9: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 10: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 11: 7% of cruciate , 4% of glycerol, 10 min.

Similar results were found by Soares *et al.* (2011) when studying application of coatings in guavas, judging the authors who The change in peel color is related to the synthetic processes associated with fruit ripening. In their study, Martins *et al.* (2020) recorded that on the eighth day, the guavas in the control group were the ones that showed the most pronounced signs of ripening, compared to those that were coated, associating the preservation of the color of the other tests with a slow release of sugars from the cell wall polymers.

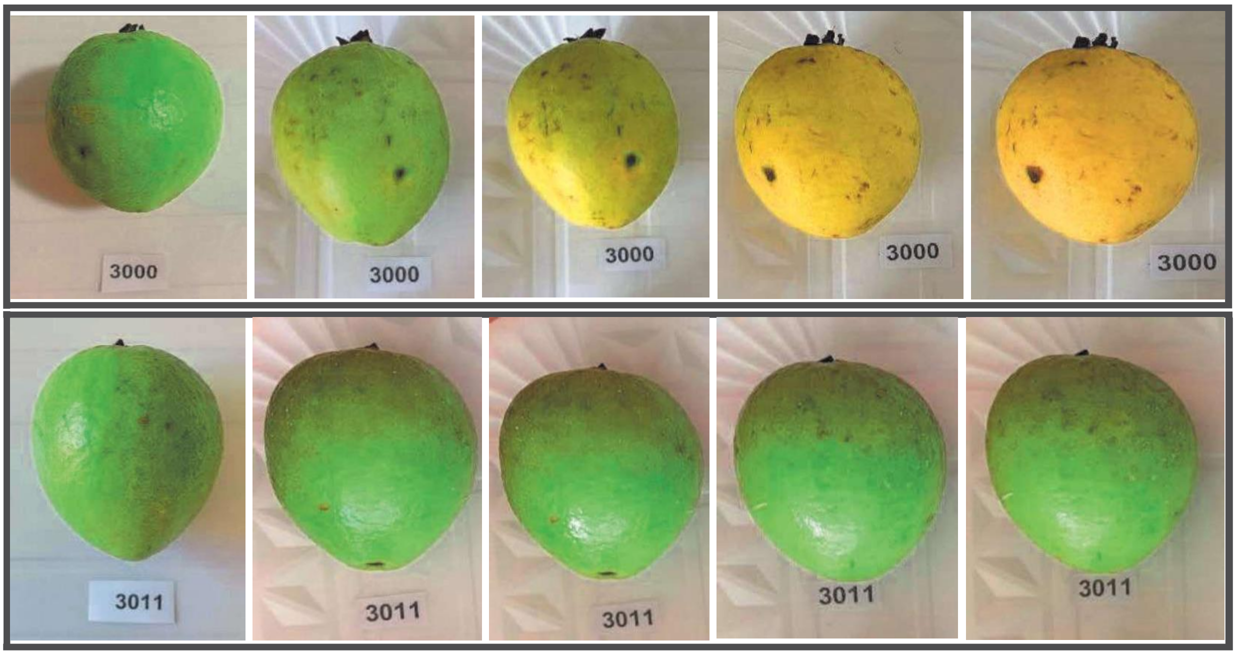
The preservation of the green color in the skin of guavas coated with polysaccharides is also pointed out by Lopes *et al.* (2018), who found a greater variation in color in the control groups of their experiment. According to the authors, chlorophyll, responsible for the green tone, can undergo a breakdown due to changes in pH during storage, in addition to the presence of organic acids, the action of oxidizing systems and chlorophyllases. Barbosa and Lima (2010) state that the ripening of guavas is noticeable between 3 and 5 days.

Silva (2021) highlights yet what the quality of product and defined put one set of variables that are of a physiological and sensory nature. Melo (2016) reports the incidence of yellow spots on coated guavas, stating that these are not defects, but are caused by a lack of uniformity in the color transition, where the yellow spots increase in size until they cover the entire fruit.

Until the eighth day, there was no incidence of rot in either the treated or untreated fruits. The general appearance of the guavas underwent minor changes during storage (Figure 6). Pereira (2018) reports that room temperature, the storage period of guavas is short, with the occurrence and evidence of nonconformities occurring with approximately of 1 week, both in packaged fruits and those kept without any type of packaging.

Figure 6

Appearance of the guavas us days 0, 2, 4, 6 and 8 of storage the 27ºC.



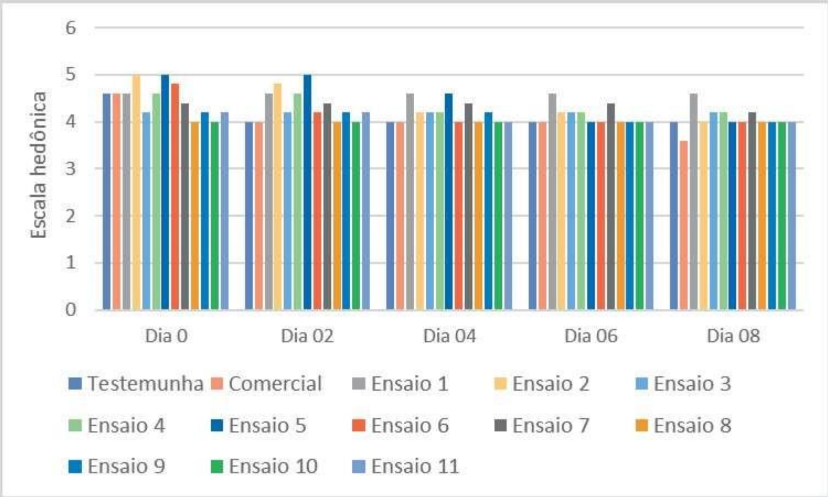
Series 3000: guavas of group control, no coated; Series 3011: guavas coated.

However, practically all fruits presented slight defects from the beginning of the experiment, which became more evident in those that were not coated, factors considered in the visual judgment (Figure 7). Slight damage is characterized as those that are caused superficially and, despite interfering with the quality and general appearance, do not condemn consumption and commercialization, being originated due to bad formations, mechanical injuries and physiological disturbances or genetics (CHOUDHURY, *et al.* 2001).

The overall quality of the guava will determine the direction of its flow in the market. Fruits with a more uniform appearance and free of injuries are consumed *in their natural state* , while those that do not meet consumer expectations are sent to the industry to be processed and transformed into derivatives, such as jams, nectars, sweets and ice cream. Thus, appearance has a direct impact on the pricing of the product (CHOUDHURY, *et al.* 2001).

Figure 7

Appearance general of the fruits during the storage



5: Excellent, free of defects; 4: Good, small defects; 3: Defects medium, no limits the consumption; 2: Excessive defects, limited consumption; 1: Rotten, unusable.
Witness: without coating; Commercial: without coating, acquired node market local; Rehearsal 1: 6% crueira , 3% glycerol, 5 min; Trial 2: 8% crueira , 3% glycerol , 5 min; Trial 3: 6% crueira , 5% glycerol, 5 min; Rehearsal 4: 8% of cruciate , 5% of glycerol, 5 min; Rehearsal 5: 6% of cruciate , 3% of glycerol, 15 min; Rehearsal 6: 8% of cruciate , 3% of glycerol, 15 min; Rehearsal 7: 6% of cruciate , 5% of glycerol, 15 min; Essay 8: 8% of cruciate , 5% of glycerol, 15 min; Rehearsal 9: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 10: 7% of cruciate , 4% of glycerol, 10 min; Rehearsal 11: 7% of cruciate , 4% of glycerol, 10 min

After analyzing the parameters and viewing the evolution of the appearance of the guavas, the action of the coating tested in test 1 in preserving the color of the group of fruits to which they were applied is noticeable.

4.1.7 Analysis microbiological of coating

Once presenting the best performance, the coating used in test 1 was subjected to tests to verify the presence of microbial contamination and the results are expressed in Table 1:

Table 5

Analysis microbiological of coating used node essay 1

Analysis	Result
Salmonella	absent
Bacillus cereus	< 10 UFC
Coliforms totals	< 3NMP
Coliforms thermotolerant	< 3NMP
AND coli	absent

Table 6

Standards microbiological of food the basis of flours and starches indicated in Normative Instruction 60, of December 20, 2019

Microorganism	n	w	m	M
Salmonella	5	0	Aus	-
***Bacillus cereus* presuntivo**	5	1	102	103
Escherichia coli/g	5	3	10	102

n: number of units the to be harvested randomly of one same batch and analyzed individually; c: number of samples that can be presented between m and M; m: maximum limit for the presence of the microorganism; M: maximum tolerable number for c samples. Source: the author (2022), adapted from Brasil (2019).

The values found were within the requirements of current legislation, Normative Instruction No. 60, of December 23, 2019, which establishes the microbiological standards for food to be offered to the consumer in its natural form, presented in Table 15 (BRASIL, 2017).

4.1.8 Analysis from the feasibility technique and economic

THE implantation of one line of production of the coating proposed in this work involves initial expenses related to the acquisition of specific equipment to be used in the processing of raw materials and development of volumetric, weighing, crushing, homogenization, and heating activities. As a structure physics, you only need a clean environment, with tables or benches for development of the activities and support. To the expenses permanent they say respect the hand of work, expenses with water and light, to the which they can to suffer variations. The Table 7 shows the initial investment required to make the process viable.

Table 7

Investment initial to the assembly of system of production of coating

Specification	Amount	Value unitary
Centrifuge	1	3,552.00
Agitator magnetic	1	511.00
Balance analytical	1	1,904.00
Stove	1	1,346.00
Mill of knives	1	810.00
Distiller of water	1	1,695.00
Thermometer	1	96.00
Kit 3 grids of iron	1	125.00
Kit Pipes falcon	1	48.00
Beaker	1	25.00

Becker Kit	1	72.00
Magnetic bar	1	14.00
Total		9,738.00

Considering that in each guava weighing an average of 150 g, 1.5 mL of the coating are adhered to its surface in the formation of the protective layer, it is possible to state that 10 liters of the coating solution guarantee the protection of 1 ton of guavas.

According to Table 15, to prepare 10 liters of coating solution, 300 mL are needed of glycerol, which currently has an average cost of R$30 per liter. The current pricing table of Companhia Pernambucana de Saneamento– COMPESA (ARPE, 2017), indicates that the current price of a cubic meter of water costs R$ 40.18, while for crueira , a material normally discarded, 600 g is needed, however, there is no price assigned to such raw material.

Table 8

Values to the production of 10 liters of coating proposed

Matter Cousin	Value of market of the raw material	Value matter press for 10 liters of solution
Cruera	-	-
Glycerol	30/ liter	R$ 9.00
Water	40.18/ m3	R$ 0.40
Value total		**R$ 9.40**

Thus, the estimated cost of producing the coating is around R$ 9.40, indicating a very low increase in production costs, with no need for a direct transfer to the commercial value, bringing the benefits indirectly.

5 CONCLUSION

The evaluation of the formulations through application to the fruits and responses obtained through the analyses performed during the experiment proved the applicability of the methodology developed in this study. Given the results, the possibility of producing a coating for preserving fruits using cassava cruera as raw material is proven, opening up prerogatives for patent registration.

It was possible to verify that the variables tested in treatment 1, composed of 6% (m/v) of cassava cruera and 3% (v/v) of glycerol, applied by immersion for 5 minutes, in addition to not offering microbiological contaminants, were efficient in preserving the guavas analyzed, extending their life span and delaying the evolution of ripening indicators, by reducing mass loss, slowing down the decrease in acidity, the increase in pH, total soluble solids and reducing sugars, in addition to maintaining the color and appearance of the fruits.

The methodology used was shown to be an easy-to-implement and low-cost procedure for assembling the structure, given the investment required for its production on a commercial scale. This characteristic results in little or no implications for the value of the final product, and important performance in increasing the shelf life of the guavas analyzed.

ACKNOWLEDGMENTS

You authors thank the Master 's support Professional in Environmental Management .

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