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Use of Agroindustrial Waste of Orange to Obtain: Bioalcohol, Essential Oils and Activated Carbon

Aprovechamiento de los Residuos Agroindustriales de la Naranja para la Obtención de: Bioalcohol, Aceites Esenciales y Carbón Activado

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Abstract

The generation of agro-industrial waste in recent years has caused a worldwide problem, which is why the concern arises to take advantage of its components to be used, sincesaid waste can be treated until the negative impact that its disposal could generate is reduced; turning them into a useful and value-added product. The objective of thisproject is to take advantage of the agro-industrial residuesof the orange to obtain bioalcohol, essential oils and activated carbon, beginning with the collection of theresidues in orchards and industries and through a pre-treatment to them, of which a part passes to a fermentation process with Saccharomyces cerevisiae and the 2nd. Part, it goes through an extraction process by hydrodistillation, the waste obtained from the previous processes is used to obtain activated carbon, in this way we generate a secondary product that benefits said process by significantly reducing any residue.

Agroindustrial Waste, Essential Oils, Activated Carbon, Bioalcohol.

Resumen

La generación de residuos agroindustriales en los últimos años ha provocado una problemática a nivel mundial, porlo que surge la inquietud de aprovechar sus componentes para ser utilizados, ya que dichos residuos pueden ser tratados hasta reducir el impacto negativo que sudisposición pudiera generar; convirtiéndolos en un producto útil y de valor agregado. El objetivo de este proyecto es aprovechar los residuos agroindustriales de la naranja para la obtención de bioalcohol, aceites esenciales y carbón activado, iniciando con la recolección de los residuos en huertas e industrias y mediante un pretratamiento a los mismos, de los cuales una parte pasa a un proceso de fermentación con Saccharomyces cerevisiae y la 2a. parte, pasa a un proceso de extracción por hidrodestilación, los desechos obtenidos de los procesos anteriores son usados para la obtención de carbón activado, de esta manera generamos un producto secundario que beneficia dicho proceso al disminuir significativamente cualquier residuo.

Residuo Agroindustrial, Aceites Esenciales, Carbón Activado, Bioalcohol.

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Introduction

Agro-industrial waste is generated by the different food and agricultural industries and is generally not of interest in the process that generates it. In recent years, several environmental problems have been linked to its generation, there is a benefit in implementing processes that allow an efficient and integral use of waste, so the concern arises to take advantage of its components to be used, since agro-industrial waste can be treated to reduce the negative impact that its disposal could generate; turning it into a useful and value-added product. In Nuevo León, orange production is 4.9% with 326,000 tonnes, and the waste generated by orange production is peel and syrup. Oranges contain fermentable sugars such as glucose, fructose and sucrose as well as insoluble polysaccharides.

Use the solid residues from the processes involved:

1. Those generated from the fermentation of oranges.
2. Those generated from the extraction of the essential oil.

Using them to obtain activated carbon and thus eliminate the waste in order to reduce the polluting effects caused by the accumulation of this waste.

In the disposal of citrus waste, between 45 and 60% of its weight is obtained as waste and is distributed in: peels (50 to 55% of the waste), peel (30 to 35%) and seeds (about 10%) (Garzón and González, 2012). This results in high quality residues during processing.

In 2014, the University of Antioquia demonstrated that orange peels are suitable for ethanol production because they contain high concentrations of soluble sugars; they are rich in soluble sugars and have a high content in sugars that can be used in the production of ethanol soluble sugars; they are rich in fermentable sugars such as glucose, fructose and sucrose.

Orange peels are particularly suitable for conversion to biofuels such as ethanol because of their polymer content and soluble and insoluble carbohydrate content, low lignin content and high concentrations of fermentable sugars such as glucose, fructose and sucrose.

Orange contains 9.35g/100g corresponding to sucrose, dextrose and levulose, protein 0.9g/100g, fat 0.1g/100g. The highly aromatic peel (exocarp) contains an essential oil rich in flavonoids.

Lignocellulosic orange residues produce activated charcoal by pyrolysis through impregnation by chemical dehydrating agents, carbonised at low cost, but with textural properties suitable for environmental uses.
Agro-industrial waste is usually produced in large quantities, so if it is not disposed of or managed properly, it can generate environmental pollution.

Our geographical area belongs to the citrus-growing region, being the orange the most consumed in the municipality of Cadereyta Jiménez, Nuevo León, mainly used in the food industry to obtain products such as juices or non-carbonated beverages.

Companies do not usually take full control of their waste, causing a serious problem for society such as the increase of greenhouse gases, soil contamination and the production of carbon footprint. Small companies on the other hand do not have the knowledge or resources to sustain a correct management and handling of waste, therefore, they discard orange peels, without having taken full advantage of the properties that they have, generating bad odour, generating bad smell, and even causing the waste to be discarded.

This generates a bad smell, an infestation of flies (or other animals) or even the incineration of the material, increasing global warming.

Hence, the need to carry out a sustainable project that allows an: Integral use of agro-industrial orange waste and use the total solid waste derived from the processes of oil extraction and alcoholic fermentation, for an application as activated carbon, as it has countless applications in the fields of: medicine, the biopharmaceutical industry and the environment.

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Development of the sections:

1. Collection of agro-industrial waste

The orange waste is collected from orchards, small juiceries in the municipality of Cadereyta.

2. Treatment of agro-industrial waste

The collected oranges are washed with potable water to remove unwanted matter. They are then sorted to discard the rotting material. They undergo a size reduction process to obtain squares of approximately 1 cm on each side, then they are dried in an oven at a temperature of 60°C for 72 hours until they are free of moisture and then ground to obtain a flour.

3. Alcoholic fermentation

A scheme is designed for the fermentation stage of the process, which allows varying the amount of yeast (0.10, 0.12, 0.15, 0.20) %, as well as the fermentation time (4, 5, 6 and 7) days respectively (see Table 1). In a container, 0.5 kg of previously crushed orange is added with 4 L of water, 0.1 to 0.2% of previously diluted yeast is added, an airlock valve is placed in the upper part of the container, the resting time for the fermentation process is 4 to 7 days, with a temperature range of 25°C. (See Table 1). After fermentation, the solids are separated (for later use) by a rapid filtration process and the filtered liquor is distilled by a simple distillation process to separate the alcohol.

4. Extraction of essential oils

A scheme for the extraction of essential oils by hydrodistillation is designed, with 60 g of sample and a time of 6 hr at 98°C, then filtered, the solid residues are dried at 60°C for 8 hr and then fermented. (See Table 2).

5. Obtaining activated carbon

For this stage a scheme is designed starting with the collection of the dry solid residues from the alcoholic fermentation and essential oil extraction processes, then we move on to chemical activation which is impregnation with an activating agent which in this case is phosphoric acid (H3PO4) at 30%, followed by agitation at 100°C for 2 hours followed by washing with distilled water and finally drying at 200°C for 4 hours (see Table 3). (See Table 3).

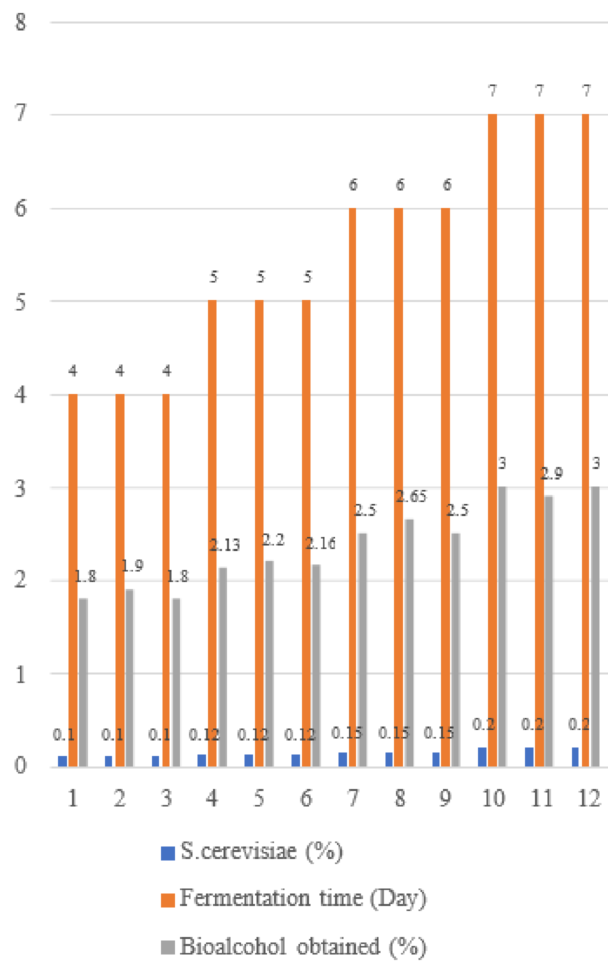

Figure 1 Obtaining bioalcohol

Ensayo (No.)	Residuo (Kg)	Agua (L)	Azucares (°Brix)	S.cerevisiae (%)	Tiempo de fermentacion (día)	Alcohol (%)
1	0.5	4	13	0.1	4.0	1.8
2	0.5	4	13	0.1	4.0	1.9
3	0.5	4	13	0.1	4.0	1.8
4	0.5	4	13	0.12	5.0	2.13
5	0.5	4	13	0.12	5.0	2.2
6	0.5	4	13	0.12	5.0	2.16
7	0.5	4	13	0.15	6.0	2.5
8	0.5	4	13	0.15	6.0	2.65
9	0.5	4	13	0.15	6.0	2.5
10	0.5	4	13	0.2	7.0	3.0
11	0.5	4	13	0.2	7.0	2.9
12	0.5	4	13	0.2	7.0	3.0

Table 1 Bioalcohol used in the production of variables

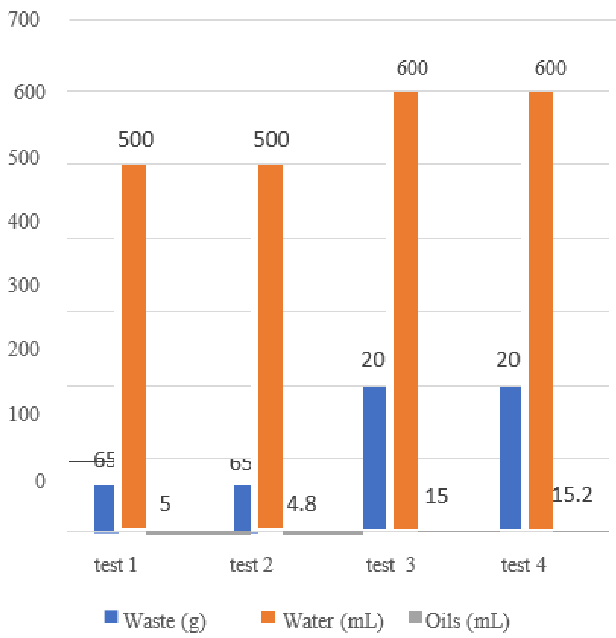

Figure 2 Oil production.

Essay	Orange waste (g)	Amount of water (mL)	Essential oils (mL)
1	65.0	500.0	5.0
2	65.0	500.0	4.8
3	200.0	600.0	15.0
4	200.0	600.0	15.2

Table 2 Variables used in the production of oils

Essay	Process waste (Kg)	Phosphoric acid 30% (L)	Distilled water (L)	Activated Charcoal (g)
1	0.1	0.250	0.4	45
2	0.1	0.250	0.4	48
3	0.1	0.250	0.4	47

Table 3 Variables used in the production of activated carbon

Methodology to be developed

1. Collection of agro-industrial waste

This starts with a plan to visit the small orchards and juice plantations in the municipality of Cadereyta, to establish the criteria for accepting their agro-industrial waste and to observe its viability for the processes, thus managing a permit to apply for it, for transfer to the processing site.

2. Treatment of agro-industrial wastes

This starts with the criterion of using oranges that are not in a state of putrefaction free of mud, leaves, animals, etc. They are then washed with potable water to remove unwanted matter.

They are then reduced in size to obtain squares of approximately 1 cm on each side, after which they are dried in an oven at a temperature of 60°C for 72 hours until they are free of moisture, and then ground to obtain a flour using an industrial blender.

3. Alcoholic fermentation

A scheme is designed for the fermentation process stage, which allows to vary the amount of Saccharomyces cerevisiae yeast (0.10, 0.12, 0.15, 0.20) %, as well as the fermentation time (4, 5, 6 and 7 days respectively) fermentation time (4, 5, 6 and 7) days, respectively (See Table 1)

In a biological reactor, 0.5Kg of previously crushed orange is added with 4L of water, 0.1 to 0.2% of previously diluted yeast is added, an airlock valve is placed at the top of the reactor, the resting time for the fermentation process is 4 to 7 days, in a heating bath with a temperature of 25°C. (See Table 1).

After fermentation, the solids are separated (for further use) by a rapid filtration process and the filtered liquor is distilled by a simple distillation process to separate the alcohol. The solid residues obtained from this process are dried in a Shel lab oven at 60°C for 8 hours.

4. Extraction of essential oils

A scheme is designed for the extraction of essential oils by hydrodistillation, in a 1000mL Florence flask, 400mL of water is added with 60 g of sample, which is previously cut and dried, in a time of 6 hrs. at 98°C, the content of essential oils is determined by the following process.is obtained by density difference with the help of a separating funnel.

The solid residue from this process is filtered and dried in a Shel lab oven at 60°C for 8 hours to be taken to the next process.

5. Obtaining activated carbon

For this stage a scheme is designed, starting with the collection of the dry solid waste from the alcoholic fermentation and essential oil extraction processes, it is weighed and we move on to chemical activation, which is by impregnation with an activating agent, in this case phosphoric acid (H3PO4) at 30%,

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Then it is taken to the carbonisation stage in the Termoscientific muffle at 380°C for 2 hours, followed by washing with distilled water in order to eliminate the remains of the acid until a neutral pH is reached, and finally it is dried at 60°C for 24 hours in the Shel lab oven.

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Conclusions

Agro-industrial wastes are organic in nature and are practically sorted at source, which facilitates their recycling, thus transforming "a problem into an opportunity".

The general objective is fulfilled with satisfactory results, however, one of the challenges of this research is to make the processes more efficient and to characterise the products from agro-industrial waste, in order to find their possible applications.

Therefore, we can conclude that through biotechnology it is possible to bioconvert agro-industrial orange waste by means of direct extraction processes (hydrodistillation), microbial transformation (fermentation) and/or chemical transformation (activated carbon) into commercial products with higher added value and greater impact, with the intention of improving environmental quality through technologies oriented towards a sustainable transformation of natural resources.

Therefore, it is concluded that, from the agro-industrial waste of the Cadereyta, Nuevo León orange, and according to the results observed:

With an initial pH between 3.0 and 4.0, adding yeast from 0.10 to 0.20% and extending the fermentation time allows us to obtain a greater amount of alcohol, which increases from 1.8 to 3.0% respectively; however, the search continues for an alternative methodology that will give us a higher percentage of alcohol, for its characterisation and future applications that will mainly benefit our community. In addition, the percentage of essential oils obtained is in a very favourable range (0.1 to 0.2%) per 100g of orange. To culminate the processes of this project, apart from obtaining alcohol and oils, it opens up the possibility of using the waste from the previous processes to obtain an activated carbon.

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