Universidad de Guayaquil
Facultad de Ingeniería Química

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Proposal to produce artisanal alcoholic beverages based on non-traditional exotic fruits such as cocona (solanum sessiliflorum), jack fruit (artocarpus heterophyllus) and salak (salacca zalacca).

Propuesta para la elaboración de bebidas alcohólicas artesanales a base de frutas exóticas no tradicionales como la cocona (solanum sessiliflorum), jack fruit (artocarpus heterophyllus) y salak (salacca zalacca).

Cristina Alexandra Macas López [1] * ; Gema Narcisa Medranda Vargas [2] ; Andrés David Peña Macías [3]

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*Autor para la correspondencia.

Abstract
In Ecuador, three exotic fruits have been found that are not commercialized in the Ecuadorian market, due to the lack of knowledge on the part of the producers and consumers, that is why it has been motivated to elaborate a distilled and fermented liquor from the cocona, jack fruit and salad to promote consumption. 28 formulations with 3 types of yeasts are made, in addition the proportions of fruits, sugar and water are controlled, the latter are left to ferment with a time variant of 15 and 30 days at 20 ° C, then they are distilled to obtain a liquor with 27 Alcoholics An internal evaluation is carried out in which the sample 1411 is chosen due to its excellent organoleptic characteristics, according to the physicochemical analysis the sample lacks methanol, after that culinary proposals such as passion fruit mousse, naranjilla cocktail and chimichurri are made are carried out Acceptance test to 60 evaluators through hedonic scale. As a result, it was obtained that in general characteristics 58 evaluators extremely like passion fruit mousse, 56 extremely like cocktail and 58 extremely like chimichurri, no evaluator dislikes any of the preparations made, this result showed that it was possible.
key words: Liquor, fruits, fermentation, distillation, gastronomy

Resumen
En el Ecuador se ha encontrado tres frutas exóticas que no se comercializa en el mercado ecuatoriano, debido a la falta de conocimientos por parte de los productores y consumidores, por ello se ha motivado elaborar un licor destilado y fermentado a partir de la cocona, jack fruit y salak para promover su consumo. Se realizan 28 formulaciones con 3 tipos de levaduras, además se varían las proporciones de frutas, azúcar y agua, estos mostos se los deja fermentar con variante de tiempo de 15 y 30 días a 20°C, luego se destila para obtener un licor con 27° alcohólicos. Se realiza una valoración interna en la que se elige la muestra 1411 debido a sus excelentes características organolépticas, según el análisis fisicoquímico la muestra carece de metanol, posterior a ello se realizó propuestas culinarias como mousse de maracuyá, coctel de naranjilla y chimichurri se procede a realizar prueba de aceptación a 60 evaluadores a través de escala hedónica. Como resultado se obtuvo que en características generales a 58 evaluadores les gusta extremadamente el mousse de maracuyá, a 56 les gusta extremadamente el coctel y a 58 les gusta extremadamente el chimichurri, a ningún evaluador le disgusto alguna de las preparaciones realizadas.
Palabras clave: Licor, frutas, fermentación, destilación, gastronomía.

1. Introduction

The purpose of this work is to produce an artisanal alcoholic beverage based on non-traditional exotic fruits such as jackfruit, salak, and cocona.

This project seeks to innovate in the development of a new alcoholic beverage using non-traditional fruits, providing small merchants who produce or distribute them with the opportunity to establish new income guidelines with research bases to maximize the properties and versatility of fruits within the liquor and gastronomic sector [1].

After the discovery of the new world, America, around 1492, produced a displacement of Europeans to this continent to have a new life with their families. And in addition to the fruits that the indigenous people had always cultivated, they were joined by the crops that the Europeans brought with them [2].

The installation of an agricultural economy, the modernization and exploitation of large mines, and the emergence of the first industries on the continent, produced a great displacement on the part of foreigners from Germany, England, Sweden, France, Italy, among others, who settled in this American continent without forgetting their culinary traditions, making it more necessary to transfer typical crops from Europe and other countries, and that thanks to the quality of the climate in America, they could be produced in an incipient way [2].

Exotic fruits in Ecuador

The main exotic fruit export in 2017 was pitahaya with a participation of 82.3% and growth of 71.3%. The first shipment arrived by sea to Miami from the canton of Palora, Morona Santiago [3].

[1] Universidad de Guayaquil; cristina.macasl@ug.edu.ec.
[2] Universidad de Guayaquil; gema.medrandav@ug.edu.ec
[3] Universidad de Guayaquil; andres.penam@ug.edu.ec .

In April, Pro-Ecuador announced that 600 kilos of granadilla, passion fruit, pitahaya, and sweet cucumber from the country entered Russia and are already being marketed on the shelves of Food City. These fruits are from Organpit. Its manager, Byron Ortiz, highlights that these products are increasingly in demand in destinations such as Russia and new markets in Asia, Europe, and the United States have potential. The main destinations are Hong Kong ($6.9 million), the European Union ($2.8 million); the United States ($1.6 million), and Canada ($1.3 million) [3].

Cocona

This herbaceous plant originated in the Amazon region, on the eastern slope of the Andes at altitudes between 600 and 1,000 meters above sea level and with an annual precipitation of 2,000 to 3,000 mm, in an area that ranges from Venezuela to the Peru border. The fruit was planted and cultivated by the Indians who lived in the Andean páramos, in the Alto Madre de Dios in the Peruvian Amazon [4].

Fig. 1. Cocona fruit.

Fruit characteristics

Mature fruits are pale yellow, orange spotted, or red. The pulp is watery, can contain 600 to 1,200 seeds, while on the intermediate side of the pulp it is usually a little solid, with an intermediate and soft firmness, yellow to yellowish white in color, with a pleasant aroma, slightly acidic, and the Brix degree of 4 to 6. The four cells are filled with seeds, wrapped in a clear mucilage, measuring between 0.2 to 2.5 cm thick.

It has a special fragrance and flavor (slightly acidic, without sweetness). The epicarp is a thin, smooth, soft layer covered with fine, purulent pubescence, which presents different colors at maturity, with uniform maturation and sometimes poor.

Table 1. Main growing areas.

Ecuador sites		
Morona Santiago	Pastaza	Orellana
Santo Domingo	Lago Agrio	Coca

1.3 Cocona varieties.

In Ecuador, there are 3 types of cocona:

- Round: yellow color, apple-like appearance
- Small: purple color
- Curved: pear-shaped

Table 2. Nutritional values of cocona.

Nutrients	Quantity
Humidity	88,5 g
Energy value	41g
Proteins	0.9g
Fiber	9.2g
Ash	0.7 g
Calcium	16 mg
Iron	1.5mg
Vitamin C	4.5 mg
Niacin	2.25 mg
Phosphorus	30 mg

Jackfruit.

The scientific name for the fruit is Artocarpus heterophyllus, and the family to which it belongs is Moraceae. It is native to the Ghats of India, Malaysia, and is now common in other parts of Asia, Africa, and some regions of South America [5].

Fig. 2. Jackfruit fruit.

Taxonomy.

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Rosales
Family: Moraceae
Tribe: Artocarpeae
Genus: Artocarpus
Species: Artocarpus heterophyllus Lam.

Jackfruit varieties.

Various studies, including those by Hossain, Saha, and Jagadeesh, have reported diversity in jackfruit, based mainly on morphological, phenotypic, and organoleptic characteristics, such as tree size, leaf structure, fruit shape, fruit production age, fruit flesh quality, size, shape, spine density, color, texture, smell, quality, and maturity period [6].

Types by fruit quality.
Fine, fibrous, and soft edibles. Pulp is generally very sweet and has a strong odor.
Thick, firm-textured pulp, often crunchy, less fragrant [6].

Basic food.
The pulp of young fruit is cooked as a starchy food and has a consistency similar to meat. Young fruit is also pickled or preserved, in brine, or in curry.

The tender young leaves are cooked and eaten as a vegetable. The seeds must be cooked by boiling or roasting before eating. They are an excellent addition to curries, can be eaten freshly cooked or dried with salt as a snack [6].

Table 3. Fruit production sectors.

Ecuador sites		
Esmeralda (Borbón, Quinde)	Pichincha (Puerto Quito) Santo Domingo (La Concordia)	Los Ríos (Quevedo, Mocache)

Table 4. Nutritional values of jackfruit.

Nutrients	Quantity
Humidity	77.2g
Energy value	98g
Proteins	1.9 g
Fat	0.3g
Fiber	1.1g
Ash	0.8- 1.0 g
Calcium	22 mg
Iron	0.5mg
Vitamin C	10 mg
Thiamine	2.25 mg
Phosphorus	30 mg

1.4 Salak
The origin of the fruit is not entirely clear, but it is believed to have been in Thailand, Malaysia, and Indonesia. Currently, cultivation has spread to Jakarta, Java, and Bali, which are all part of Indonesia. This is because the fruit was brought to these areas by merchants who sold or traded it. In recent years, cultivation has spread throughout Southeast Asia, to countries such as Thailand, Singapore, and Malaysia. It is also well known in the United States and Japan.

Fig. 3. Salak fruit.

Taxonomy
- Scientific name: Salacca
- Family: Aracaeace
- Genus: Salaca
- Species: Salacca Zalacca [7]

Fruit characteristics
The fruits of this palm tree generally grow in clusters that can contain 15 to 40 fruits. One of the characteristics of the fruits, regardless of variety, is that they have astringency due to the amount of tannins produced during the ripening process. In many cases, this level decreases considerably when the fruit has fully ripened. The fruits have a bulbous appearance that joins at a point at one end.

Underneath its scaly skin, there are three lobes of white to yellowish color. Its flavor is tropical, with hints of acidic fruits such as pineapple. Its varieties diversify by their dryness, while other snake fruits are moist and juicy [8].

Fermentation
Fermentation is a metabolic process that uses yeast to obtain energy and nutrients from organic compounds. These are then converted into ethanol and carbon dioxide. This process is anaerobic because yeast converts sugar into ethanol in the absence of oxygen [9].

Types of fermentation
Alcoholic fermentation
This is a biological process that is initiated by yeast. Yeast is responsible for processing sugar until it is converted into alcohol. This process of fermentation is anaerobic, which means that yeast can perform its function without the need for oxygen [10].

Acetic fermentation
This is basically the oxidation and transformation of alcohol into acetic acid. This occurs in the presence of oxygen and air. The microorganism responsible for this fermentation is Cetobacter aceti [10].

Lactic fermentation

As the name suggests, this is the transformation of lactose into lactic acid. The microorganism responsible for this transformation is Lactobacillus [10].

2. Materials and methods

In particular for the experimentation process of the fruit liquor, where the following fruits were used as main raw materials:

- Salak
- Cocona
- Jackfruit

Utensils and equipment are used for fermentation, for distillation (see table 5) raw materials (see table 6) as well as cleaning materials (see table 7), the aforementioned is of great importance for obtaining the final product.

Table 5. Materials used for fermentation

Resource	Quantity	Description
Clear buckets	28	Food grade plastic, with pressure lid and airtight pipe. With a capacity of 4 liters.
Hose	28	Plastic, circumference 5cm and 50 cm long.
Bowls	5	Stainless steel, capacity of 1 liter.
Blender	1	-
Sieve	1	-
Spoon	3	Stainless steel, no holes.
pH meter	1	Digital.
Refractometer	1	Portable.
Alcohol meter	1	
Knife	2	Handle of polyethylene and stainless steel blade.
Cutting board	2	Polyethylene.
Scale	1	Digital.
Gram scale	1	Digital.

Table 6. Utensils and equipment used in distillation.

Resource	Quantity	Description
Thermometer	1	Mercury.
Round-bottom flask	1	Round-bottom, capacity of 500 ml.
Condenser tube	1	Thermostatic.
Extension	1	Thermostatic.
Collection flask	1	Thermostatic, capacity 250 ml.
Clamp	3	Stainless steel.
Laboratory nut	3	Stainless steel.
Support base	2	Stainless steel.
Rubber hose	2	40 cm long.
Sieve	2	-
Gas and its equipment	1	Domestic use.
Bunsen burner	1	Bunsen.
Alcohol meter	1	
Measuring jug	1	

Table 7. Materials used (raw materials)

Raw Materials
Salak
Jackfruit
Cocona
Drinking water
Sugar
Baker's yeast
Wb-06 yeast
S-04 yeast
Vs-05 yeast

Table 8. Cleaning materials

Resource	Quantity	Description
Neutral soap	2	Liquid.
Ethyl alcohol	3	96%
Latex gloves	2	De látex.

Sensory test

The purpose of the sensory test is to measure the degree of acceptance that the product has in the evaluator. For this, a minimum amount of the product is given to taste to the group of evaluators selected at random.

In fact, they proceed to assess the organoleptic characteristics of the sauce, cocktail, and dessert that contain the fruit liquor. The information collected is used to know the degree of acceptance that the product will have in each organoleptic characteristic.

Acceptance test

According to [11], the acceptance test requires 50 to 75 consumers, selected at random. Within this framework, an acceptance scale is determined, whether it is a degree of acceptance, dislike, or preference. As it is an alcoholic beverage, sauces, desserts, and cocktails are made based on it. The aforementioned is developed so that the evaluator can distinguish the organoleptic characteristics that the liquor possesses [12].

Hedonic test

In hedonic tests, the consumer is asked to rate the overall satisfaction level (liking) that a product produces for them using a scale provided by the analyst. These tests are a very effective tool in product design and are increasingly being used by companies because it is the consumers who ultimately make a product a success or failure [13].

3. Results

3.1 General analysis of the surveys

The surveys were conducted in the parish of Tarqui, Ecuador, because it meets all the relevant characteristics for the research. According to the data provided by the Finta formula for sample size and distribution, it was

concluded that 384 surveys should be conducted with people who live in the area or frequently visit it [14].

People of all social classes and an initial age range were considered, according to the country's laws. A range of 18 to 22 (142), 23 to 26 (40), 27 to 30 (89), and over 30 (113) was used, with young people in the first range having the most surveys. Of the total men and women, it was noted that the first group was lower with 117, while the second group with 267 was the highest percentage [15].

The questionnaire was created based on the questions that were asked about the project, based on the raw materials found and the final product that was produced. An important aspect was to ask if they consumed alcohol, determining that 89.58% did and 10.42% did not. This data is in line with the statistics of the World Health Organization, which show that Ecuador is the 16th largest consumer of alcoholic beverages in the world. However, most people only drink alcohol on special occasions (36.92%). The most popular alcoholic beverages are beer and wine. It is important to note that people consume alcohol directly or indirectly, as in the food they prepare [16].

The degree of knowledge of the fruits that are used as raw materials in the production of the liquor was measured. The results showed that 61.6% of the respondents were unaware of these fruits. This suggests that it is important to promote these varieties of fruits through various means. The other 25% of respondents were familiar with jackfruit, 2.9% with cocona, and 10.4% with salak.

The results of the surveys showed that there is a high acceptance of the liquor. The vision is to emphasize it in different culinary preparations. This would allow for the development of new products with completely different flavors from the usual ones, thereby expanding the food market.

3.2 Formulations

First stage:
It was developed at the Cuatro Hermanos farm, owned by Mr. Enrique Peña Alarcón, who provides the physical space on his land located in the Los Ángeles neighborhood, belonging to the canton of Buena Fe in the province of Los Ríos. The fermentation took place from December 10, 2018 to January 10, 2019, with a total of 18 formulations proposed, where two variables were determined: with and without sugar, as well as 3 different types of yeast at a temperature of 20°C. After fermentation, the products were transported to the city of Guayaquil for subsequent distillation at the facilities of the ESPOL University under the supervision of Engineer Joel Vielma.

3.3 Variant of S-04 yeast

Table 9. Formulation 1

Ingredients	%	Quantity	Description
Salak	20	440 g	Peeled, chopped, and cooked.
Water	79,9	2.200 ml	Potable
Yeast	0,1	2,2 g	Tipo S-04

Formulation # 1
The formulation starts with 20% of salak, previously blanched, 79.9% of water, and 0.1% of S-04 yeast activated in potable water at room temperature for 10 minutes. This gives a total of 2,642 g of must with an initial pH of 4. After 30 days, the pH drops to 3.5. After sieving, a final liquid of 1,100 ml is obtained, with no alcohol content. The distillate was performed at 80°C with 3 repetitions of 300 ml of the fermented liquid, which did not show any presence of alcohol. The result of the experimentation was not correct due to the lack of degrees brix in the must.

Table 10. Formulation 2

Ingredients	%	Quantity	Description
Salak	20	440 g	Peeled and chopped.
Water	79,9	2.200 ml	Potable
Yeast	0,1	2,2 g	Tipo S-04

Formulation 2
The percentages used in the present formulation are 20% of fruit, 79.9% of water, since salak has little water. In addition, 0.1% of S-04 yeast activated in potable water at room temperature for 10 minutes is added. This gives a total of 2,642 g of must with an initial pH of 4.5. After 30 days, the pH drops to 3.8. After sieving, a final liquid of 1,100 ml is obtained, with no alcohol content. The distillate was performed at 80°C with 3 repetitions of 300 ml of the fermented liquid, which did not show any presence of alcohol. The result of the experimentation was not correct due to the lack of degrees brix in the must.

Table 11. Formulation 3

Ingredients	%	Quantity	Description
Cocona	20	440 g	Washed and chopped
Agua	79,9	2.200 ml	Potable
Levadura	0,1	2,2 g	Tipo S-04

Formulation 3
20% of fruit and 79.9% of water are used, in addition to 0.1% of S-04 yeast activated in potable water at room temperature for 10 minutes. This gives a total of 2,642 g of must with an initial pH of 3.5. After 30 days, the pH drops to 3. After sieving, a final liquid of 1,100 ml is

obtained, with no alcohol content. The distillate was performed at 80°C with 3 repetitions of 300 ml of the fermented liquid, which did not show any presence of alcohol. The result of the experimentation was not correct due to the lack of degrees brix in the must.

Explanation:
The results of the three formulations of liquor produced with salak and cocona fruit using S-04 yeast were not successful. The reason for this was the lack of degrees brix in the must, which is a measure of the sweetness of the fruit. Without enough sugar, the yeast is not able to produce enough alcohol.

To improve the results of the experiments, the researchers could try using other types of yeast or adding more sugar to the must.

3.4 Determination of Brix degrees

A Brix degree analysis was performed using a Fisher Scientific refractometer from 0º to 30ºBrix on each fruit to determine the initial degree of each fruit. An extract of each fruit was added by dripping onto the glass and the result was read, where the Jackfruit obtained 15º, the cocona 6º and the Salak 8º. In the first stage of experimentation, the formulations were formed based on the Brix degree of each fruit, reaching a range of 5º to 8º Brix in the must, obtaining unfavorable results in the final fermentation. In the second stage, refined sugar is added to mix with the fruit to obtain an increase in Brix degrees in the must with variables of 25º to 30º, where it reached a higher fermentation. The Brix degree that reached in the must of the final formulation is 32ºBrix. It was determined to use formulation#28 with the percentage of 20% of added sugar, and a final must of 32ºbrix to achieve the optimal alcohol content for the final product.

Table 12. Formulation 4

Ingredients	%	Quantity	Description
Jack Fruit	19	326 g	Washed and pulped.
Water	80,9	1.720 ml	Potable
Yeast	0,1	1,7 g	Tipo S-04

19% of fruit, 80,9% of water are used, adding 0,1% of S-04 yeast activated in potable water at room temperature for 10 minutes, giving a total of 2.047 g of must with an initial pH of 4. After 30 days, the pH drops to 3.5, after sieving, a final liquid of 996 ml is obtained, in which no alcohol content is present. The distillate was performed at 80ºC with 3 repetitions of 300 ml of the fermented liquid, where at the end there was little presence of alcohol. The result of the experimentation is not correct due to the lack of Brix degree in the must.

Table 13. Formulation 5

Ingredients	%	Quantity	Description
Jack Fruit	13,8	108,6 g	Washed and pulped
Salak	13,8	108,6 g	Peeled, pulped and cut.
Cocona	13,8	108,6 g	Peeled and cut.
Water	20	62,5 ml	Potable
Sugar	38,4	125 g	White
Yeast	0,1	0,3 g	Tipo S-04

A mixture is made with the three fruits in percentages divided equally by 13,8%, water 20% and 01% of S-04 yeast activated in potable water at room temperature for 10 minutes, including as a variant 38,4% of sugar to analyze the effects it contributes to the must, giving a total of 513 g starting with a pH of 4. After 30 days the pH drops to 3, after sieving, a final liquid of 256 ml is obtained, in which there is a minimum amount of alcohol.

The distillate was performed at 80ºC with 256 ml of the fermented liquid, where at the end the presence of a minimum amount of alcohol is reflected by touch due to the fact that the amount required to measure in the alcoholimeter is not necessary. The result of the experimentation is acceptable due to an increase in GL degrees in the distillation.

Table 14. Formulation 6

Ingredients	%	Quantity	Description
Salak	20	440 g	Peeled, chopped and cooked
Water	79,9	2.200 ml	Potable
Yeast	0,1	2,2 g	Baker's yeast in a bar

Next, 20% of previously bleached salak, 79.9% water, and 0.1% of bread yeast activated in potable water was added to the rested environment for 10 minutes, giving a total must of 2,642 g, starting with a pH of 4. After 30 days, the pH was reduced to 3.5, and when sieved, a final liquid of 1,000 ml was obtained, in which no alcohol was present. The distillation was carried out at 80ºC with 3 repetitions of 300 ml of the fermented liquid where at the end it did not reflect the presence of alcohol. The result of the experiment is not correct due to the lack of brix degrees in the must.

3.5 Determination of the alcoholic strength.
To obtain the alcoholic strength of the finally distilled alcoholic beverage, the alcohol is measured manually with a Gay Lussac 0-100 alcoholmeter. The alcohol must be placed inside a test tube at a temperature of 20° Celsius for the respective analysis of the experiments. In the first stage, it was not possible to obtain a high amount of distilled liquor, due to the lack of brix in the must, so the total liquid required for the alcoholic test was not produced, because of which the presence of °GL was

identified by touch and taste, where most of the tests showed negative results and others showed a low presence. In the second stage, the Gay-Lussac degree test is performed, where the result is positive with a range of 25° to 30° for 550 ml, and a third stage where the final liquor is established as 27° Gay Lussac. Adhered to INEN 1837 Standards where it can be considered a liqueur.

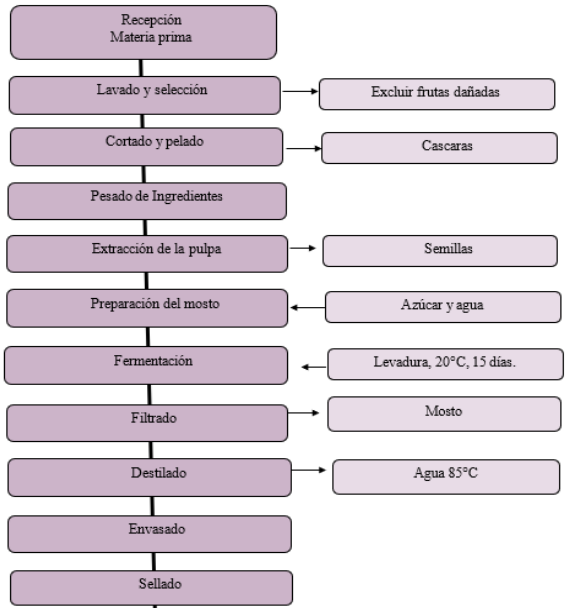

Fig. 4. Flow chart for obtaining the liquor.

4. Conclusions

A total of 384 surveys were conducted among the inhabitants of the Tarqui parish. This methodology helped to determine the different preferences of the respondents for a given product, which showed that 31.7% of those surveyed prefer beer, 23.2% wine and 17% liquor, which suggests that liquor is an alcoholic beverage preferred by consumers.

Twenty-eight formulations were made with variations in time, temperature and percentages, of which sample 1411 was the most suitable, its organoleptic characteristics were due to its fermentation time of 15 days at 20°C, its distillation at 85°C produced 27° alcoholic, in addition there was no methanol thanks to the innocuous fermentation and distillation process, standard recipes of passion fruit mousse, naranjilla cocktail and chimichurri with liquor in its preparation were made.

Applying the alcoholic beverage in 3 culinary preparations, allows to appreciate the organoleptic characteristics that the liquor contributes to the preparations of passion fruit mousse, naranjilla cocktail and chimichurri, such characteristics could be known through the hedonic test carried out to 60 panelists, In general characteristics, 58 evaluators liked extremely and very much the passion fruit mousse, 56 liked extremely and very much the cocktail and 58 liked extremely and very much the chimichurri, none of the evaluators disliked any of the preparations.

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