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Parameters of Quality in the Production of Piloncillo in Sabanas Huatusco, Veracruz

Parametros de Calidad en la Producción de Piloncillo en Sabanas Huatusco, Veracruz

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Abstract

The development of panela or brown sugar in Mexico takes place in small factories or mills commonly called rural agribusinesses. The process is usually handmade, it does not have quality control measures such as good manufacturing practices (GMP) and measurement of physicochemical parameters that can be monitored by the producers to ensure the quality and safety of the product. The importance to evaluate these parameters to contribute to a continuous improvement process to obtain a competitive product in the market. The aim of this study was to determine the quality parameters in each stage of preparation of brown sugar and the final product, by characterizing, monitoring, control and physicochemical analysis of different samples obtained during the process. The results obtained on physicochemical parameters such as humidity, PH, Color Icumsa, ° Brix, Pol, Purity, in the stages of milling or cane juice extraction, concentration of juice or cane syrup and final product, show that they are affected by the degree of maturity and variety of cane used, and the time exposed to high temperature, meladura (cane honey) concentration and adequate filtration process and clarification.

B.rown sugar, Piloncillo, Physicochemical parameters

Resumen

La elaboración de panela o azúcar morena en México se realiza en pequeñas fábricas o ingenios comúnmente llamados agroindustriales rurales. El proceso es generalmente artesanal, no se cuenta con medidas de control de calidad como buenas prácticas de manufactura (BPM) y medición de parámetros fisicoquímicos que puedan ser monitoreados por los productores para garantizar la calidad e inocuidad del producto. La importancia de evaluar estos parámetros para contribuir a un proceso de mejora continua para obtener un producto competitivo en el mercado. El objetivo de este estudio fue determinar los parámetros de calidad en cada etapa de preparación del azúcar moreno y del producto final, mediante la caracterización, seguimiento, control y análisis fisicoquímico de diferentes muestras obtenidas durante el proceso. Los resultados obtenidos sobre parámetros fisicoquímicos como humedad, PH, Color Icumsa, ° Brix, Pol, Pureza, en las etapas de molienda o extracción de jugo de caña, concentración de jugo o jarabe de caña y producto final, muestran que son afectados por el grado de madurez y variedad de caña utilizada, así como el tiempo de exposición a alta temperatura, concentración de meladura y adecuado proceso de filtración y clarificación.

Azúcar B.rown, Piloncillo, Parámetros fisicoquímicos

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Introduction

The main uses of sugarcane are the production of crystal sugar, piloncillo or panela and obtaining fodder. In Mexico, sugar cane is produced in diverse climates, soils, and cultural conditions.

Sugar in Mexico has a considerable market size, its consumption is widespread in the domestic sphere and it has a significant demand in the industrial sector. Mexico is among the top ten sugar producing and consuming countries in the world. A small part of the sugar cane production is for the production of piloncillo (in the center and north of the country) also known as panela (in the south). , which is obtained from the concentration and free evaporation of the cane juice.

The area planted with sugar cane in Mexico is distributed mainly in the state of Veracruz, where it is cultivated on an annual average, 253 thousand hectares, which represents 36.7% of the national total. It constitutes the main perennial crop in the state and is established in 90 municipalities of the entity where around 380 sugar mills are located in the different municipalities of the central zone of the state, such as: Huatusco, Comapa, Fortín, Sochiapa, Totutla, Zentla, Atzacan and Paso del Macho. However, very low economic yields are obtained due to poor and precarious processing conditions, since traditional and artisanal practices are used. (Chavez, 2011; Cortez, 2013; Leano 2013) since traditional and artisanal practices are used. (Chavez, 2011; Cortez, 2013; Leano 2013) since traditional and artisanal practices are used. (Chavez, 2011; Cortez, 2013; Leano 2013)

Literature review

The cultivation of sugar cane gave rise to an agro-industrial system that occupies a preponderant and transcendent place in the economic and social activity of Mexico. This activity was initiated by the Spanish conquerors and currently a whole productive tradition has been created where cane is grown and processed in 61 mills located in Campeche, Chiapas, Colima, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Quintana Roo, San Luis Potosí, Sinaloa, Tabasco, Tamaulipas and Veracruz. (http://www.veracruz.gob.mx)

The sugarcane agribusiness is of the utmost importance for the Mexican economy, despite the crisis that has occurred in recent years in our country, sugarcane has been an important source of direct and indirect employment in the different sugarcane regions of the country. .

It is estimated that the production of piloncillo in Mexico participates with 2.3% of the national production of sweeteners from sugar cane, with an average of 115 thousand tons, if taken as a base, almost 5 million tons of sugar produced per year. anus. The Food and Agriculture Organization of the United Nations FAO, (http://teca.fao.org), reports an average of 36 thousand tons of production for the period 1999-2001. The national production of sugarcane is carried out in 683,008 hectares that generate 48,363,316 tons of raw material that supply 58 sugar mills or sugar factories located in 15 sugarcane states with productivity of the grass where 13% of the national population lives. The supply zones cover 227 municipalities, in which more than 12 million people live. Que contribuyen de manera importante al desarrollo industrial del país. (Zafranet, 2008; http://www.siap.gob.mx)

In the sugar mills, the labor force is employed to carry out harvesting, transportation and planting tasks. It also influences the activities of the tertiary sector (services), providing income to the population that forms part of the economy of these agroindustrial regions during the five months of the harvest. The sugar agroindustry in Veracruz is made up of 22 sugar mills that represent 36 percent of the national sugar plant, which are supplied by an industrializable surface of 233 thousand 11 hectares of sugar cane and provide direct and indirect employment to 145 thousand people in the field and 22 thousand in the factory, which generates a total of 167 thousand jobs.

In Veracruz, a population of one million people depends on this economic activity (COVECA, 2008). Piloncillo production is an important source of income in the region of Huatusco-Fortín, Veracruz, because throughout the year it is a significant source of income for families living in this area and represents a major contribution to family spending, with the highest production of piloncillo occurring from January to June.

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The average number of workers per mill is 12 employees for a regional total of 2,550 jobs generated, considering an average of four members per family, together with the 213 families of mill owners, it can be considered that 11,052 inhabitants of the region depend economically on the production of piloncillo. (Córtez 2013)

However, various factors threaten the competitiveness of the sugar industry as an economic activity, such as the low productivity of the fields and industry, as well as international sugar prices. The substitution of sucrose for high fructose corn syrups and synthetic sweeteners, the instability in oil prices, among others.

The diversification strategy must take into account the efficient use of the potential of sugarcane in order to increase added value, based on cutting-edge technologies and the application of biotechnology, as a complement to sugar production. From the sugar cane harvest and processing it is possible to obtain eight products and by-products (sucrose, ethanol, crop residues, bagasse, molasses, filter cake, stillage and boiler ashes). However, the industrial production of sugar cane derivatives and by-products has not shown constant development and in the Mexican sugar industry there has not been a significant change in the pattern of diversification in recent decades. The problem lies in the absence of a national model of diversification, the lack of knowledge and information are factors that constitute the main obstacle for a sugar cane agriculture (agricultural sector), biofactory (industrial sector) with efficient and sustainable production. (Aguilar, 2012)

Processso of production of Piloncillo

The manufacture of piloncillo was observed in three trapiches located in the town of Sabanas, municipality of Huatusco, belonging to the central zone of Veracruz, in which the elaboration procedure is artisanal and is carried out empirically. The average production is 1,300 to 1,500 kg per day; the variety of cane used as raw material corresponds to CP-290 (Canal Point), CP-2086, pata de fierro, 1210 and RD. (Chavez 2011)

Cut

The process begins with the cutting and storage of the cane. The cane producers in the area have as a cultural tradition the cut by thinning. They do not have technical measurement controls to determine at what time of the year the cane should be harvested. The cut is carried out by observation according to the maturity of the sugar cane or due to economic necessity, which forces them to process it ahead of time; regularly the cut is made in the months of October to May. (Chavez 2011)

Herd and Transportation

Once the cane is cut, it is rolled up, raised and transported in cargo trucks to the mill. On some occasions, the cane must be stored in the cutting place before being transported. When it arrives, it is prepared in the raw material reception area; in some cases it is stored for long periods of time. (Chavez 2011)

Msmell

In the mills, the extraction of cane juice is carried out by means of physical compression by a dough or roller mill which is operated by a person (miller), who is in charge of introducing the cane rolls manually. A solid residue called bagasse is also obtained, which still contains a high percentage of moisture and sucrose, which is why it is carried by a person (green bagasse) next to the grinding area where it is stored for drying naturally. Once the bagasse is dry, it is carried by another person (dry bagasse) next to the burner and is used as.

Precleaning

At this stage of the process, different methods of pre-cleaning the raw juice are observed, one of them is the use of nursery meshes to manually filter and remove all solid and larger residues. Another of the methods observed is the use of uneven tanks which settle the sludge and large particles of the extracted juice. This separation prevents the precursor substances of the color from being released due to the effect of heat and reduces the amount of solid incrustations in the pans, increasing its useful life and the rate of heat transfer.

The juice from the pre-cleaner passes to the storage tank where the sludge settles and is extracted through an orifice into black sheet or food-grade stainless steel tanks. (Chavez 2011)

Clarification

LThe next stage is the clarification of the juices, which is carried out in order to eliminate impurities in suspension, colloidal substances and some colored compounds initially through coagulation and later by flocculation, by adding sodium bicarbonate (NaHCO3) and milk of lime (CaO). At this stage is where the work of the operators (Tachero, Pailero and Trapichero) begins. Once the juice is received in the first tank it begins to heat up and based on the experience of the operator, the necessary amount of Bicarbonate is added. sodium (NaHCO3) and the slurry.

Concentration and evaporation

At this stage of the process, the concentration of juice begins, which is carried out with the help of the oven (constantly fed by bagasse) until reaching the necessary temperature according to the experience of the pailero. There are three pans where the juice begins to evaporate until it obtains a viscous consistency (molasses or honey)

In some trapiches they add complements to help give consistency to the molasses, such as the addition of panela, sugar and water. During this stage, high temperatures have been reached, approximately 120 to 128 °C, and a concentration of 65 to 70°Brix, which is why the operator keeps the syrup in constant movement to prevent it from sticking to the bottom of the pan and if this happens, the necessary amount of animal fat (bait) must be added. (Chavez 2011; Mosquera 2007)

Cooling

In one of the mills, the honeydew is emptied manually by two people into a pan, which is activated by rotating blades, allowing it to cool down, leaving it ready for molding. This operation is carried out according to experience because they have not defined the time that must remain in the rotating pan. In other trapiches, the syrup is emptied by means of gravity and through a stainless steel channel it is poured into the mixer.

Once the pailero gives the syrup the correct point according to his experience, the wooden molds which have been previously washed with water to prevent the honeydew that forms the piloncillo from adhering. The filling of the molds is done manually by the operators, (Banker) These are placed on rustic shelves for approximately 15 minutes to solidify and later unmold on cement plates.

Packaging and storage

When the panela has dried and cooled, it is packed in cardboard boxes by one or two operators depending on the production obtained. Once packed, the final product is weighed and then stored in the warehouse. (Chavez 2011)

Iallology

In the present work, a methodology was established in the measurement of the different physicochemical parameters, such as Humidity, PH, Color Icumsa, °Brix, Pol, Purity, etc., that contribute to ensure the quality of the piloncillo produced in the central zone of the state. from Veracruz.

Sampling for analysis

TheThe samples were taken from three mills located in the town of Sabanas, municipality of Huatusco, Veracruz. For their identification, they were called Trapiche 1, 2 and 3. Trapiche 1. Located in Manzana el Cantillo. Trapiche 2. Located in the Manzana Tejerías. Trapiche 3. Located in the Manzana la Esperanza. Samples were obtained in triplicate from different points that are key in the piloncillo production process. The juice samples were taken at the extraction stage (mills), the molasses from the concentration area, and the piloncillo samples from the finished product area.

The juice was placed in clean, dry plastic bottles and refrigerated at 4°C to prevent it from degrading and losing important properties for later analysis. A sample of 4 liters of juice from the concentration stage was taken, which was cooled in a "bath-marie" to be packaged in new plastic bottles. Samples of 1 kg of piloncillo were taken once cooled and unmolded and placed in sterilized plastic bags until completing 3 samples.

Analysis of physicochemical parameters

The physicochemical analyzes of each sample were carried out according to the methods indicated in the official Mexican standards that are mentioned below:

NMX-F-275(1992) Determination of Brix degrees in juice samples from sugar-producing plant species - solids and specific weight (hydrometric method) - test method.

NMX-F-271(1991) Determination of pol (apparent sucrose) in samples of juices from plant species that produce sugar - normal weight method.

NMX-F-266(2012) Determination of pH in samples of sugar cane juice, molasses and molasses.

NMX-F-235-1991 Determination of pol (apparent sucrose), in samples of syrup, cooked mass, molasses, washed and final molasses.

NMX-F-079(2012) Determination of polarization at 20 ºC

NMX-F-526(2012) Determination of color by absorbance in sugars.

NMX-F-294 (2011) Determination of humidity in samples of crystallized sugars.

Determination of ° Brix in cane juice

Certified Brix Hydrometers were used, with scales from 0 to 10, 10 to 20 and 20 to 30º Brix, and certified Thermometers, with a scale in degrees Celsius.

Determination of Pol in cane juice

For the determination of Pol in cane juice, a digital electronic saccharimeter (Autopol) was used, with a scale in degrees S. 26 g of sample, previously homogenized, were weighed. Subsequently, the sample is placed in the capsule and quantitatively transferred to a 100 ml Kohlrausch flask and calibrated with distilled water, keeping the content at 20 °C Lead subacetate was added to the sample. The sample was placed in a 250 ml beaker, discarding the first 25 ml of the filtrate.

The polarimetric tube was rinsed two or three times with the filtered solution 200 mm, and later it was filled with the remaining solution to take the reading.

Determination of ° Brix in Meladura

A 100 cm³ test tube was filled with the sample, eliminating the foam, and it was left to stand for 20 minutes until the occluded air bubbles were completely eliminated. The Brix hydrometer was carefully introduced, in such a way that the stem was submerged one centimeter from the position in which it should remain stable, floating freely. The temperature of the sample was taken. The observed reading was corrected for temperature, using for this effect the Table "Corrections for temperature to hydrometer readings °Brix”.

Determination of pH in Meladura

150 ml of a homogeneous sample of syrup was poured into a beaker and the pH was measured with a potentiometer with automatic temperature adjustment.

Determination of Pol at 20 ºC in Piloncillo

A 26 g sugar sample was taken in a capsule and transferred to a 100 ml Kohlrausch flask rinsing with distilled water to a volume of approximately 80 ml. The sample was stirred until completely dissolved at a temperature of 20 °C, for which it was placed in a water bath. Subsequently, the sample was made up to a volume of 100 ml with distilled water and stirred until the complete formation of the precipitate, it was filtered and the first 25 ml of the filtrate were discarded. The polarimeter tube was rinsed with the sugar solution to approximately two thirds of its capacity; then it was filled with this solution at 20 °C avoiding the presence of air bubbles. The tube was placed in the polarimeter, three determinations were made at 20 °C and the reading was recorded.

Determination of Color by Absorbance in Sugars (Piloncillo)

A solution was prepared with 50 g of the piloncillo sample and 50 g of distilled water, dissolving and stirring at room temperature.

The solution was vacuum filtered using a 0.45μm filter membrane; the filtered solution was deaerated for one hour at room temperature in an ultrasonic bath for one minute.

Subsequently, the samples were read in a spectrophotometer at a wavelength of 420 nm.

Moisture determination in crystallized sugar samples (piloncillo).

To determine the surface moisture content in crystallized sugar samples, 10 g of each were placed in capsules previously dried in an oven at 105°C and at constant weight.

Subsequently, the samples placed in the capsules were weighed on an analytical balance and placed in the oven for 3 hours to dry them. They were weighed again to determine weight loss during drying. Weight loss was expressed as a percent of the original mass of the samples.

Results

LThe results obtained in the physicochemical analyzes carried out on the different samples of raw cane juice, molasses and piloncillo, are shown in the following tables.

DETERMINACIONES FISICOQUIMICAS EN JUGO DE CAÑA			
	PARAMETROS		
	GRADOS BRIX	% POL	PUREZA
TRAPICHE 1			
MUESTRA NO. 1	17.64	13.72	77.778
MUESTRA NO. 2	17.75	13.98	78.761
MUESTRA NO. 3	17.98	13.97	77.697
TRAPICHE 2			
MUESTRA NO. 1	18.84	16.47	87.420
MUESTRA NO. 2	18.96	16.44	86.709
MUESTRA NO. 3	18.86	17.14	90.880
TRAPICHE 3			
MUESTRA NO. 1	18.06	15.91	88.095
MUESTRA NO. 2	18.34	15.57	84.896
MUESTRA NO. 3	17.58	16.39	93.231

Table 1 Physicochemical determinations in cane juice

DETERMINACIONES FISICOQUIMICAS EN MELADURA					
	PARAMETROS				
	GRADOS BRIX	% POL	PUREZA	PH	% EVAPORACION
TRAPICHE 1					
MUESTRA NO. 1	73.78	55.81	75.644	5.06	76.09
MUESTRA NO. 2	72.1	54.32	75.340	5.07	75.38
MUESTRA NO. 3	71.1	55.96	78.706	5.09	74.71
TRAPICHE 2					
MUESTRA NO. 1	75.54	55.69	73.723	5.48	75.06
MUESTRA NO. 2	75.24	55.99	74.415	5.51	74.80
MUESTRA NO. 3	75.28	55.17	73.286	5.50	74.95
TRAPICHE 3					
MUESTRA NO. 1	74.6	59.23	79.397	5.40	75.79
MUESTRA NO. 2	74.74	58.69	78.526	5.41	75.46
MUESTRA NO. 3	74.82	58.56	78.268	5.41	76.50

Table 2 Physicochemical determinations in honeydew

DETERMINACIONES FISICOQUIMICAS EN PILONCILLO			
	PARAMETROS		
	% POL	COLOR	HUMEDAD
TRAPICHE 1			
MUESTRA NO. 1	70.96	13834	1.449
MUESTRA NO. 2	71.00	14466	2.231
MUESTRA NO. 3	70.2	14690	2.050
TRAPICHE 2			
MUESTRA NO. 1	67.98	32032	0.637
MUESTRA NO. 2	68.78	37727	0.917
MUESTRA NO. 3	69.07	32165	0.784
TRAPICHE 3			
MUESTRA NO. 1	71.9	12061	1.043
MUESTRA NO. 2	71.22	12759	1.354
MUESTRA NO. 3	71.94	12841	1.189

Table 3 Physicochemical determinations in piloncillo

As can be seen in Table no.1, the values obtained for the cane juice samples from trapiche 1 are lower in the analyzed parameters, Brix degrees, % polarization and degree of purity, compared to the values obtained in the samples from mills 2 and 3, which is due to the variety and quality of cane used (CP cane point, RD and iron leg). In addition to not having the physiological maturity required to make the cut and process it. Thes samples from mill 2 have a higher % of polarity and purity, which can be attributed to the quality and physiological maturity of the sugar cane used, in addition to not exposing the raw material to room temperature for long periods of time in the area of reception. In relation to the pH values obtained in the samples of trapiche 1, they are lower than those observed for the other two trapiches and that according to the reported data it has been determined that the optimal pH of the cane juice to obtain quality panela.

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It must be between 5.6 and 5.8, thus avoiding the formation of reducing sugars, favoring clarification, and facilitating decachazada (Mosquera, 2007). Regarding the values of the parameters analyzed in the syrup samples, reported in Table 2, it is observed in the results obtained in the analysis of °Brix in syrup (concentrated juice that was evaporated between 75 to 80% of the water content) in which trapiche 1 has less °Brix compared to trapiche 2 and 3. When comparing the results with the parameter established by the NMX-F-266-SCF-2012 standard where the syrup has a value of 55 to 65 °Brix, it is considered that the syrup used for panela has a higher concentration of sugars, as it is a product in its purest state, obtaining a parameter of 70 to 76 °Brix.

The results in Pol of trapiche 3 are higher compared to trapiche 1 and 2. It is observed that in trapiche 2 there is less purity due to the fact that during the concentration process water and panela (in a deteriorated state) were added, which is also reflected in the % of Polarity with respect to the samples of trapiche 3 and affects the quality of the final product (color). The samples from trapiche 3 were the ones that presented the highest values in terms of % of Polarity and Purity.

In relation to the pH, considering as a reference a parameter already established in a sugar process, it presents values of 5.8 - 6.3, the results obtained are similar, unlike trapiche 1, which presents low pH values, which depends on factors such as temperature and the time used to obtain the concentration and clarification of syrup, stage of the process in which CaO is added (lime milk), as well as the physiological maturity of the raw material.

In other studies, it has been observed that clarifying the juice at a temperature of approximately 60°C favors the clarifier to act efficiently, which allows the speed of movement of the particles present in the juice to be accelerated, facilitating the elimination of impurities. In some cases, the need to make a second addition of fining agent at a temperature between 75 and 85 °C has been reported (Ortega, 2004).

Thes determinations made on piloncillo samples in Table no. 3, show the results of the % of Polarity and it is observed that the values of trapiche 2 are lower with respect to the values of trapiches 1 and 3, due to the concentration of sugars that is influenced by the factors temperature and time in the process of concentration and clarification of the syrup In relation to the values obtained in the color of the piloncillo It is observed that the samples of mill 2 on average correspond to 32,165 IU and differ from the values obtained in mills 1 and 3 which present average values of 14,466 and 12,061 IU respectively. This indicates that the panela from trapiche 2 has a dark color and is considered in the market as a third quality product. The piloncillo from mills 1 and 3 have a light color and are considered top quality. So the color attribute is an important factor that determines its price in the market.

Regarding the humidity values of the different samples, it is observed that the piloncillo of mill 1 presents a humidity of 2,231% and mill 3 of 1,189%, being the piloncillo of mill 3 the one with the highest humidity when compared to mill 2, which It is 0.637%, which is due to the high temperatures and the cooking time at which the honeydew is processed, coupled with the fact that a variable amount of water and stored panela were added in the same process. This parameter is important for the producer because it is one of the most appreciated quality indices in the market.

Conclusions

The results obtained indicate that the physicochemical characteristics of the cane juice, such as: °Brix, Pol and Purity, depend on the maturity and varieties used as raw material in the sugar mills, through which it is possible to determine the yields of the final product. As for the Syrup, the physicochemical characteristics °Brix, Pol, Purity and pH are determined by the process time and the high concentration temperatures. As for the physicochemical characteristics of the Piloncillo such as Color, Humidity and Pol, it depends on an adequate process filtration and clarification. On the other hand, the lack of control and equipment to carry out monitoring in each of the stages of the process in the mills, result in the final product not having the quality and safety standards required to achieve competitive products in the market. piloncillo market.

LThe results obtained in this work applying analytical techniques to evaluate the quality of piloncillo, molasses and cane juice, will serve as a reference and will help producers consider carrying out the necessary analyzes at each stage of the process. achievesstandardizing the operating conditions and obtaining quality products, In the raw material reception area, it is recommended to reduce the length of stay of the cane in the sugar mill facilities before grinding, since the sun dehydrates the stem, generating acidification of the juices and acceleration of the investment of sucrose into sugars. reducers. This affects the yield for °Brix in juice and Pol in cane, since sucrose (Pol) is usually lower than the expected results.

To improve the extraction of cane juice, it is recommended to calibrate the mills, this will help to obtain better efficiency in grinding and reduce the loss of juice and a lower moisture content in bagasse.

The cane juice obtained from the mill should remain in the storage tank for as short a time as possible to prevent the juices from acidifying and sucrose from degrading, and to avoid using a greater amount of lime for its neutralization.

To guarantee an efficient process of eliminating impurities from the juice, a pre-cleaner must be adapted that guarantees a good separation of impurities, such as the use of meshes of different sizes and uneven sedimentation tanks, since these impurities are precursors of the color in juice and remain in the final product

When juices with low pH are present, food grade lime milk or lime must be added, preparing aqueous solutions in adequate concentrations.

In the evaporation and concentration of the juices, it must be carried out in a short period of time. In this way, the breakdown of reducing sugars is reduced in this stage.

Thus promoting the inversion of sugars due to high temperatures (greater than 100°C), which affects the final product's consistency, humidity, color and polarity.

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