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Presentation of the Content

In the first chapter we present, *Crop coefficient of pomegranate in the Comarca Lagunera* by SIFUENTES-MORÍN, Norma Guadalupe, MONTEMAYOR-TREJO, José Alfredo, SERVÍN-PRIETO, Alan Joel and OROZCO-VIDAL, Jorge Arnaldo with adscription in the Instituto Tecnológico de Torreón, as a second article we present *Food granulation as a sustainable and survival means* by SALGADO-LOYO, Eduardo, CRUZ-GÓMEZ, Marco Antonio, MEJÍA-PÉREZ, José Alfredo and FLORES-MARTÍNEZ, Guillermo with adscription in the Benemérita Universidad Autónoma de Puebla, as the following article we present *Intelligent system for monitoring motor pumps in the water supply to optimize crop rotation* by LOREDO-MEDINA, Raúl, FIGUEROA-MORENO, Alejandro, HUMARÁN-SARMIENTO, Viridiana and ARCE-CÁRDENAS, Francisco Javier with affiliation at the Instituto Tecnológico Superior de Guasave, as the following article we present. *Safflower seed (Carthamus tinctorius L.) invigoration by pre-hydration*, by QUINTANA-CAMARGO, Martín, PICHARDO-GONZÁLEZ, Juan Manuel, AVENDAÑO-LÓPEZ, Adriana Natividad and ROMAN-MIRANDA, María Leonor, with adscription in the Centro Nacional de Recursos Genéticos, INIFAP and Universidad de Guadalajara.

Content

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Crop coefficient of pomegranate in the Comarca Lagunera

Coeficiente de cultivo de granado en la Comarca Lagunera

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Abstract

For agricultural development, water is the most important thing, so today farmers are looking for crops that have some degree of resistance to drought and high economic value such as pomegranate, however, there is poor literature on its production. The Crop Coefficient (Kc) helps us determine the water requirement during plant development, which is critical for reducing production costs and saving water. The objective of this study was to know the Kc during the phenological development of the pomegranate, in an orchard located in the municipality of Gómez Palacio, Durango, Mexico, using 8 Landsat satellite images and geographic information systems. The estimation of Kc based on the Normalized Difference Vegetation Index (NDVI), was performed as proposed by Calera (2016). The KC values obtained range from 0.33 to 0.65. Its evolution with satellite images is consistent according to the development stages of the crop. The relationship between the NDVI and KC may be a promising tool for farmers to estimate water use of pomegranate trees on a regional scale based on satellite imagery.

Crop coefficient, NDVI, Pomegranate

Resumen

Para el desarrollo agrícola el agua es lo más importante, por eso hoy en día los agricultores están en busca de cultivos que tengan algún grado de resistencia a la sequía y de alto valor económico como el granado, sin embargo, existe poca literatura sobre su producción. El coeficiente de cultivo (Kc) nos permite conocer el requerimiento hídrico durante el desarrollo de la planta, el cual es fundamental para la reducción de costos de producción y ahorro de agua. El objetivo de este estudio fue conocer el Kc durante el desarrollo fenológico del granado, en una huerta ubicada en el municipio de Gómez Palacio, Durango, México, por medio imágenes satelitales Landsat 8 y sistemas de información geográficas. La estimación del Kc en función del el Índice de Vegetación de Diferencia Normalizada (NDVI), se realizó según lo propuesto por Calera (2016). Los valores obtenidos de Kc varían desde 0.33 y 0.65. Su evolución con las imágenes de satélite es congruente de acuerdo con las fases de desarrollo del cultivo. La relación entre el NDVI y Kc, puede ser una herramienta prometedora para que los agricultores estimen uso del agua de los árboles de granado en escala regional basada en imágenes satélites.

Coeficiente de cultivo, NDVI, Granado

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Introducción

For the agricultural development of any country, water is the most important thing, that is why today research is looking for crops that have some degree of resistance to drought and of high economic value (Zang, 2017). The pomegranate can grow in different agroclimatic conditions, from temperate to tropical regions (Meshram, 2019), in addition to being able to moderately tolerate salinity (Bhantana, 2010). Its highest production is in India with 108,000 ha, 71,000 ha in China, 65,000 ha in Iran, 27,000 ha in Turkey, and 6,000 ha in Spain (Stover and Mercure, 2007), (Ayars, 2017). Production in Mexico in 2019 was 1,068 ha. (SIAP, 2020)

Today, the pomegranate is a highly lucrative agricultural business, due to the monetary return per unit of area. This has resulted in an increase in the plantation, and the export of pomegranate during the last two decades. (Meshram, 2019).

Many studies on the great benefits of using pomegranate in medicine, both the leaves, bark, roots and fruit can be used for this purpose. (Ayars, 2017).

The fruit is one of the oldest known. However, there is little literature on its production, knowing the water requirement during the development of the plant is essential to reduce production costs, especially during the dry season. (Zang, 2017).

Remote sensing is an alternative technology that has been developed in recent years, the most important characteristic is that, thanks to its radiometric calibration, it is possible to make conversions to physical values of reflectivity, giving them a homogeneity that makes them perfectly comparable with each other. in multitemporal studies, from which vegetation indices are calculated (Valdés, 2016); Thanks to the vegetation indices, we can systematically evaluate the quantity, quality and development of a crop's vegetation. (Balbontín, 2016).

Remote sensing NDVI can be a good way to monitor growth stages and water demand, due to the relationship of crop water content to near-infrared (NIR) reflectance and wave-infrared portion short (SWIR) of the specification. (Zang, 2017).

So, this is an indicator of the photosynthetic activity of the plant and from which it is possible to derive the crop coefficient. This can be used in adjusting the water needs of crops within the FAO56 model (Allen, 1998). (Valdés, 2016).

Developing a simple method for estimating Kc values would be a great benefit; remote sensors are a viable economic alternative that provide information with high spatial and temporal resolution. (Castañeda, 2015). Different experimental works have derived the Kc from vegetation indices obtained with satellite images. (Calera, 2016)

The objective of this study was to know the Kc during the phenological development period, of the pomegranate crop in La Comarca Lagunera, in the states of Coahuila and Durango, Mexico..

Methodology

Description of the study area

The study was carried out at the ranch "El Triángulo" in Gómez Palacio Durango with coordinates 25 ° 37'41 "North 103 ° 26'54" West, and 1123 meters above sea level.

The evaluated crop was the two-year-old Wonderful variety pomegranate. The study area was twenty hectares, the crop is in a planting frame of three bolillo of three by five meters and a density of 666 trees ha-1. The irrigation system was drip, one dripper per tree of four liters per hour was located.

Figure 1 Z one of study, located in the municipality of Gómez Palacio, Durango
Source: Own elaboration

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Data required

To carry out this study, images from the Landsat 8 satellite acquired by the OLI and TIR sensors were used, which were obtained from the portal of the United States Geological Survey (USGS). http://earthexplorer.usgs.gov/.

In addition, a digital elevation model at 30 m was used obtained from the portal of the National Institute of Statistics and Geography (INEGI).

Date	Path / Row
18/02/2016	30/42
05/03/2016	30/42
21/03/2016	30/42
09/06/2016	30/42
25/06/2016	30/42
11/07/2016	30/42
12/08/2016	30/42
13/09/2016	30/42
15/10/2016	30/42
31/10/2016	30/42
16/11/2016	30/42

Table 1 Landsat images used in the study
Source: Own elaboration

Image processing

The pre-processing of the images was carried out with the ArcGis 10.3 software, which allows the use of a series of tools specially designed to process satellite images.

For this, it is necessary to convert the values of digital levels (ND) of each pixel to physical parameters, to obtain the spectral radiance and reflectance, these parameters represent the physical bases for the SEBAL processing and are carried out by using software GIS, via raster calculator tool.

Transformation of ND values to radiance

For the conversion of these values to radiance levels, the "spectral radiance scaling method" is used, which is expressed with the following formula (USGS, 2016):

$$L\lambda = ML * Qcal + AL \qquad (1)$$

Where:

$L\lambda$ = It is the value of spectral radiance measured in values of (Watts / m2 * srad * μm).

ML = It is the multiplicative specific scaling factor obtained from the metadata.

AL = It is the additive specific scaling factor obtained from the metadata.

Qcal = Standard product quantified and calibrated by pixel values (ND).

The data required to apply the formula is found within the image metadata, in the .MTL file.

Transformation of ND values to reflectance

For the conversion the following equation is used (USGS, 2016):

$$\rho\lambda' = M\rho * Qcal + A\rho \qquad (2)$$

Where:

$\rho\lambda'$ = It is the planetary reflectance value.

$M\rho$ = It is the multiplicative factor of specific scaling obtained from the metadata.

$A\rho$ = It is the additive specific scaling factor obtained from the metadata.

Qcal = Standard product quantified and calibrated by pixel values (ND).

The data required to apply the formula is found within the image metadata, in the file. MTL.

Surface albedo (α)

The surface albedo is obtained by the linear combination of the reflectances, in the first instance the albedo is obtained in the upper part of the atmosphere (αtoa) by the following equation:

$$\alpha_{toa} = \sum{}_{\omega\lambda * \rho\lambda'} \qquad (3)$$

Where:

$\rho\lambda'$ = It is the planetary reflectance value.

$\omega\lambda$ = It is obtained with the following equation:

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$$\omega\lambda = \frac{ESUN\lambda}{\sum ESUN\lambda} \quad (4)$$

ESUN values are obtained from Table 2.

	LANDSAT 8 OLI					
Band	**Low**	**High**	**Center**	**Linear**	**ESUN TOA**	**$\omega\lambda$**
2 (Blue)	0.45	0.51	0.480	1991	2067	0.3026
3 (Green)	0.53	0.59	0.560	1812	1893	0.2759
4 (Red)	0.64	0.67	0.655	1549	1549	0.2336
5 (REL)	0.85	0.88	0.865	962.6	972.6	0.1417
6 (SWIR)	1.57	1.65	1.610	251.7	245	0.0357
7 (SWIR)	2.11	2.29	2.200	86.30	79.72	0.0116

Table 2 Corresponding ESUN values for LANDSAT 8 OLI scenes. USGS

Where, ESUNλ is the mean solar exo-atmospheric irradiance for each band (W / m2 / μm).

Finally, to calculate the surface albedo, the equation described by (Allen et al., 2002) is used.

$$\alpha = \frac{\alpha\text{toa} - \alpha\text{path\_radiance}}{\tau_{sw}2} \quad (5)$$

The value of these variables oscillates between the range of 0.025 and 0.04, according to the use of SEBAL it is recommended to use the value of 0.03 (Bastiaanseen, 2000).

τ_sw = Corresponds to atmospheric transmissivity which is calculated by the following equation, (Allen et al., 2006).

$$\tau_{sw} = 0.75 + 2\ x\ 10^{-5}\ x\ z \quad (6)$$

Where:

z = is the elevation above sea level (m).

Typical surface albedo values for different surfaces are presented in Table 3

Surface	Rank
Snow	0.80 – 0.85
Black soil	0.08 – 0.14
Pasture	0.15 – 0.25
Cornfield	0.14 – 0.22
Rice field	0.17 – 0.22
Forest	0.10 – 0.15
Water	0.025-0.348

Table 3 Typical albedo values according to the type of surface

Source: Allen, 2002.

Vegetation Indices

Vegetation indices are used to highlight the characteristics of healthy vegetation and developed against the ground.

Normalized Vegetation Index (NDVI)

The NDVI, according to Rouse et al., 1974, is estimated as follows:

$$NDVI = \frac{(IRC-R)}{(IRC+R)} \quad (7)$$

Where:

IRC = corresponds to the reflectivity in the near infrared band, while

R = refers to the reflectivity in the red band.

Determination of Kc with satellite images from NDVI

The estimation of the Kc based on the NDVI was according to what was proposed by Calera (2016), whose formula for its estimation, valid mainly for annual crops, is:

Kc= 1.25*NDVI+0.1

According to the author, the equation carries a series of limitations that it is important to consider when applying it to calculate evapotranspiration (ETc) and the water needs of the crops under study. Thus, in their maximum development phase they achieve complete soil coverage. In the germination phase of crops or in the case of crops such as garlic, onions, etc., where in their maximum development phase they do not reach complete soil coverage, the evaporative component of the soil can be very high, and therefore therefore, this method will tend to underestimate the value of Kc. The formula was applied for each of the phases.

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Results

In Table 4, the NDVI values obtained in the different development dates of the pomegranate crop.

Date	Julian day	NDVImax	NDVImin	NDVIaverage
18/02/2016	49	0.217214	0.099375	0.187266
05/03/2016	65	0.337619	0.108201	0.245869
21/03/2016	81	0.437426	0.145578	0.336978
09/06/2016	161	0.494853	0.10572	0.358889
25/06/2016	177	0.508704	0.135227	0.366808
11/07/2016	193	0.530918	0.135735	0.386618
12/08/2016	225	0.548841	0.187262	0.443249
13/09/2016	257	0.543986	0.183996	0.414608
15/10/2016	289	0.595187	0.122032	0.427126
31/10/2016	305	0.556329	0.112361	0.417664
16/11/2016	321	0.560583	0.114595	0.416978

Table 4 NDVI values for pomegranate cultivation
Source: Own elaboration

NDVI values between 0.21-0.59 are recorded. There were no negative values, as there were no bare soil conditions.

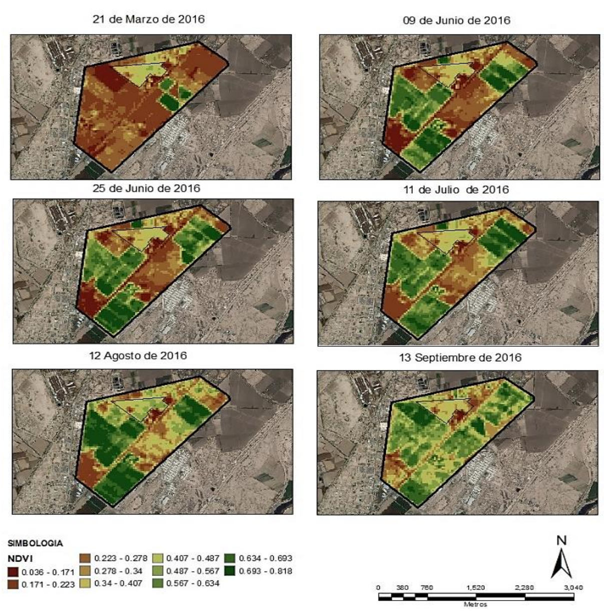


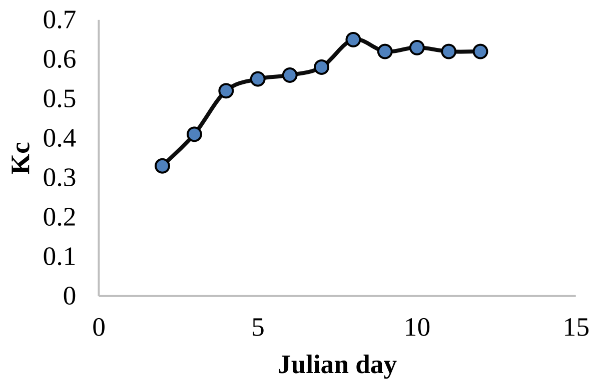
Figure 2 Variations of NDVI in the phenological period of the pomegranate, during the study time
Source: Own elaboration

Date	Julian day	KC
18/02/2016	49	0.33
05/03/2016	65	0.41
21/03/2016	81	0.52
09/06/2016	161	0.55
25/06/2016	177	0.56
11/07/2016	193	0.58
12/08/2016	225	0.65
13/09/2016	257	0.62
15/10/2016	289	0.63
31/10/2016	305	0.62
16/11/2016	321	0.62

Table 5 Kc of pomegranate variety Wonderful
Source: Own elaboration

Based on the NDVI, the Kc obtained for pomegranate in 2016 is shown in Table 5.

The Kc values obtained vary from 0.33 to 0.65. The evolution of Kc with satellite images is congruent according to the development phases of the crop, in the initial phase, when the trees are still dormant, the value is small. And the highest is in August, when the pomegranate reaches its maximum coverage. In the collection phase, the Kc values, as expected, are decreasing as observed in graphic 1.



Graphic 1 Behavior of the pomegranate cultivation coefficient during its phenological development, expressed in Julian days
Source: Own elaboration

Values like those reported by the authors Bonet and Bartual (2012) in Alicante Spain; but below those reported by Meshram and Gorantiwar (2010) in India, corresponding to the second year of life of the tree.

The current study confirmed that this method is an alternative for the determination of the KC in pomegranate, and with it to know the water needs in each phenological stage.

Annexes

Pomegranate production in Mexico

Year	Surface (ha) Sown	Harvested	Sinister	Production (ton)
2019	1,068.00	974	20	7,144.43
2018	1,206.25	1,058.00	0	8,073.88
2017	1,084.90	946.9	0	6,816.22
2016	812.9	725.9	0	5,209.59

Table 6 Production of Pomegranate in Mexico per year in tons, with cycle: Ciclicos-Perenes, modality: Irrigation + Temporary
Source: SIAP, 2020

Conclusions

The KC was obtained based on the normalized vegetation index (NDVI) for the cultivation of the Wonderful variety pomegranate, established in the El Triángulo ranch, according to the climate and soil of that site. The relationship between NDVI and Kc that have been established may be a promising tool for farmers to estimate water use of pomegranate trees on a regional scale based on satellite imagery.

The Kc calculation methodology (Calera, 2016) yields consistent results for the analyzed crop, although it would be interesting to deepen the study by doing a more detailed analysis and repeat the experiment for at least one more year. With this cultivation coefficient they are intended to be used as reference information, in a way that allows improving water efficiency, not only in the amount of water, but also at the right time to irrigate.

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Food granulation as a sustainable and survival means

La granulación de alimentos como medio sustentable y de supervivencia

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Abstract

The consumption of avocado is of great importance in the daily diet of the human being, since this fruit contains high levels of Omega 3 and various vitamins (B6, B9 and E) and minerals (magnesium, iron, zinc and phosphorus). Today, Mexico is one of the main avocado producers worldwide. However, the high demand and the low production of this fruit makes the price of avocado more expensive and, therefore, the Mexican population reduces its consumption and seeks nutritional alternatives. For this reason, this research aimed to propose the manufacture of solid avocado tablets (based on pharmaceutical techniques) by granulating and compacting the dehydrated powder of this fruit. This was carried out under a mixed approach by applying quantitative and qualitative technologies to systematic, critical and empirical processes in order to choose the best granulation technique, the ideal binder and the type of compaction to use to achieve solid tablets using dehydrated avocado powder. This tablet aims to preserve the same nutrients as natural avocado and reach all sectors of the population to generate a sustainable and human survival environment.

Food dehydration, Granulation, Binder

Resumen

El consumo de aguacate es de gran importancia en la dieta diaria del ser humano, ya que esta fruta contiene niveles altos de Omega 3 y diversas vitaminas (B6, B9 y E) y minerales (magnesio, hierro, zinc y fósforo). Hoy en día, México es uno de los principales productores de aguacate a nivel mundial. Sin embargo, la alta demanda y la escasa producción de esta fruta provoca que el precio del aguacate sea más caro y, por ende, la población mexicana reduce el consumo de este y busca alternativas nutricionales. Por tal motivo, esta investigación tuvo como objetivo proponer la fabricación de pastillas sólidas de aguacate (con base en técnicas farmacéuticas) mediante la granulación y compactación del polvo deshidratado de esta fruta. Esta fue realizada bajo un enfoque mixto al aplicar tecnologías cuantitativas y cualitativas a procesos sistemáticos, críticos y empíricos con la finalidad de escoger la mejor técnica de granulación, el aglutinante ideal y el tipo de compactación a utilizar para lograr pastillas sólidas mediante polvo deshidratado de aguacate. Esta pastilla pretende conservar los mismos nutrientes que el aguacate natural y llegar a todos los sectores de la población para generar un medio sustentable y de supervivencia humana.

Deshidratación de alimentos, Granulación, Aglutinante

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Introducction

A study by the UN revealed that more than 820 million people usually go to bed hungry in the world, therefore, the sustainability of the food system must be a primary objective worldwide. Likewise, it is necessary to effect a profound change in the international agri-food system, since approximately 1,300 million tons of food (produced for human consumption) is wasted or lost. United Nations [UN]. (s.f.) and Sustainability. (s.f.).

Today, Mexico is one of the main avocado producers worldwide. However, and according to statistical data published by PROFECO, in the month of July there is a considerable increase in the price of this fruit in the country, due to high demand and low production due to climatic changes, worker strikes, etc. Therefore, the production of dehydrated avocado powder could be an economical solution when the production of this fruit is lower in the country. Since, the dehydration of the avocado prevents the oxidation of fats, the decomposition of the compounds and, therefore, does not lose its main nutritional properties. Barría, C. (2019), PROFECO (2019) and Ramos Solís, R. (2006).

Year	Avocado price to the consumer in Mexico (in pesos)
2012	39 (±2)
2013	45 (±2)
2014	43 (±2)
2015	40 (±2)
2016	57 (±2)
2017	72 (±2)
2018	57 (±2)
2019	75 (±2)

Table 1 Price of avocado to the consumer in Mexico during the month of July 2012-2019
Source: PROFECO, (2019)

However, this product would present economic losses for its manufacturers, because they must turn to nutrition experts to indicate the ideal amount of avocado powder to consume per meal. Likewise, the powdered avocado could present losses in its packaging. For these reasons, an alternative to solve these problems could be the manufacture of solid avocado tablets by granulating and compacting the dehydrated powder of this fruit based on the pharmaceutical techniques used in the manufacture of solid oral dosage forms.

This alternative could be carried out by substituting the powder of the active ingredient of the drug for the dehydrated avocado powder during the pharmaceutical granulation process. However, in order to achieve successful avocado tablets, the moisture percentage of the dehydrated avocado powder, the speed of binder addition during granulation, binder viscosity, levels of use of the binder in granulation, the different techniques to obtain granules must be considered. and the compaction of granules to generate solid tablets of oral dose.

Methodology

This research has a mixed approach which applies quantitative and qualitative technologies to systematic, critical and empirical processes. The application of the quantitative method was necessary for the analysis of cause and effect in sequential processes in order to predict a hypothesis. To control this research, descriptive, correlational and explanatory fields must be combined taking into account the environment of the phenomenon, in such a way that there is a correlation between variables for easy understanding. It should be noted that this research requires a non-experimental study, since the changes over a certain time were analyzed by observing the phenomenon in its natural context. For this reason, it was necessary to apply the qualitative method, since it allows to deepen about the phenomena related to the problem, proposing possible results of the data obtained under an inductive process; contextualizing the topic with the use of primary research sources such as: written materials (books, newspaper articles, notes), as well as web pages. Hernández, 2010, p.275.

Methodology used to obtain avocado powder

Dehydration of avocado paste

Previous studies determined that avocado powder and natural avocado have almost the same nutritional contribution (Omega 3, vitamins B6, B9 and E and the minerals magnesium, iron, zinc and phosphorus), because the biomolecules present are almost in the same proportions. This can be confirmed by using the following methodologies. Avocado calories: energy value in 100 g and nutritional sheet. (May 21, 2019) and Ramos Solís, R. (2006).

First, a ripe avocado must be selected without any type of plague in order not to affect its sensory characteristics. Subsequently, the pit and peel are separated from the avocado pulp. In the next step, the avocado pulp milling is done to increase the mass and heat transfer area of the avocado pulp to obtain a paste of 904 g / cm^3. The paste obtained from grinding is placed in the dehydrator containers, taking care that the paste does not exceed 2 cm in thickness. Ramos Solís, R. (2006).

By following the steps above, the pasta must go through a cooling process before dehydration. At this stage, a refrigeration chamber (1-5 ° C) should be used for at least one hour to achieve adequate cooling. When the product is in contact with cold air it releases energy to the surrounding environment and thus this leads to a temperature gradient causing a conductive heat transfer from the core to the surface and a phase change (crystallization of water). On the other hand, on the surface of the product there is a transfer of water between the product and its surroundings, because the concentration of water vapor in the surrounding air is less than the concentration of water vapor in the air in equilibrium. Therefore, the cooling process limits the development of microorganisms and prevents oxidation of the avocado paste by lowering its temperature below its freezing point. Mulot, V., Benkhelifa, H., Pathier, D., Ndoye, F.-T., & Flick, D. (2019) and Ramos Solís, R. (2006).

Lastly, the containers containing the avocado paste are dehydrated in a freeze dryer (under the sublimation principle). Drying by freeze drying is used in foods that spoil or undergo changes in their structure due to the high temperatures used in conventional drying methods. For this experimentation, the drying time of the avocado paste was in different time intervals (2-10 h). Among the parameters to control in dehydration, the pressure in the vacuum chamber of the lyophilizer must be less than atmospheric (between $450x10^{-3}$ and $50x10^{-3}$ mbar) and the minimum temperature of the freeze-dryer condenser should be -40 ° C. Ramos Solís, R. (2006).

Analysis of the pharmaceutical techniques for obtaining avocado granules

Granulation process

Wet granulation is the most widely used technique in the pharmaceutical industry, because it enables the use of little fluid, less compressibility and, therefore, elegant, safe and effective pharmaceutical products such as tablets and capsules are achieved. This technique is developed in three stages: wetting-nucleation, growth-consolidation and wear-breakage. During wetting, binder liquid is added to the powder mixture. Nucleation begins with the formation of small granules. During these stages, the binder spreads by capillary action and the growth of the granules is dependent on viscous forces. Excellent wetting and nucleation depend on various parameters, for example, the nature, amount and properties (viscosity, density, wettability, solid-liquid contact angle) of the binder. Likewise, the growth of the granules is influenced by the degree of saturation of the pores with the binder. In the same way, the coalescence and consolidation step represent the growth and densification of granules due to collisions and, therefore, this step influences the porosity of the granules. Lastly, the wear and tear step occur when the granules break due to impact, wear or compaction in the granulator.

On the other hand, among the different wet granulation techniques, the ones commonly carried out in the industry are "HSWG" high shear granulation, "FBG" fluidized bed granulation and "TSG" twin screw granulation. Arndt, O. et al. (2018), Dürig, T., & Karan, K. (2019), Suresh, P., Sreedhar, I., Vaidhiswaran, R., & Venugopal, A. (2017) and Thapa, P., Tripathi, J ., & Jeong, SH (2019).

High cut granulation "HSWG"

HSWG is one of the most widely used techniques in the pharmaceutical industry because its process is short in time, presents denser granules, requires less binder compared to other techniques, etc. Furthermore, several types of excipients are compatible with this technique.

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However, this granulation technique has some disadvantages, for example, the mechanical degradation of brittle particles, the chemical degradation of materials sensitive to high temperatures and the possible formation of lumps due to excess humidity. In the same way, this technique presents several critical parameters that have a great relevance in the physical and mechanical properties of the final granules. Suresh, P. et al. (2017) and Thapa, P., Tripathi, J., & Jeong, S. H. (2019).

Twin screw granulation "TSG"

TSG is a continuous technique that involves kneading the powder mixture using two interlocking co-rotating screws encased in a barrel with powder and liquid injection ports. The powder mixture and granulation liquid is conveyed along the screw to achieve granulation. This process is good for heat sensitive materials and the yield percentage of its granules is 98%. This technique presents a higher load of the active principle of the drug and, therefore, enables the efficient mixing of the starting materials, the distribution of the binder solution during the wetting phase and the densification of the granules formed. However, any variation in screw length, geometry and diameter can affect the properties of the granules and thus the properties of the tablet. Suresh, P. et al (2017), Thapa, P., Tripathi, J., & Jeong, S. H. (2019) and Wang, L. G. et al (2020).

Fluidized bed granulation "FBG"

This technique consists of a nozzle, a solution delivery system, and compressed air to atomize the liquid binder. In the FBG, a distributor plate allows to retain the dust in the container, while the filters (at the top of the column) allow the air to pass through and, on the other hand, these filters prevent the solid particles from escaping. After the powder is fluidized, the binder solution is sprayed (via spray nozzles) onto the fluidized bed to begin agglomeration of granules. Finally, the granules are dried by blowing air through the system. In FBG, the agglomeration rate is guided by operating parameters, for example, spray speed, fluidization speed, nozzle position, and atomizing air pressure. In the same way, this technique is suitable in heat sensitive materials and the percentage of yield of its granules is 99%. On the other hand, this process requires little energy to dry large surfaces.

However, FBG requires more liquid solution during the process which generates highly porous granules. Arndt, O. et al. (2018), Askarishahi, M. et al. (2019), Suresh, P. et al. (2017) and Thapa, P., Tripathi, J., & Jeong, S. H. (2019).

Parameters of the most common binders in wet granulation

In wet granulation, the suitable binder must possess adequate surface wetting capacity in order to ensure optimum adhesion and cohesion between interparticulate surfaces in the wet state. Therefore, the ideal binder produces dense, uniform granules with low friability and a high degree of compactness.

In the pharmaceutical industry, hydroxypropylcellulose "HPC", methylcellulose "MC", ethylcellulose "EC", povidone "PVP" and partially gelatinized starch "PGS" are the most used binders. On the one hand, HPC is used with water, hydroalcoholic solvents, and polar organic solvents. The typical use level of this binder is 2-6% and it exhibits 2% viscosity 5, 8 and 12 cps (respectively). On the other hand, MC is used with water or hydroalcoholic solvents. Typical use level for this binder is 2-10% and has a 2% viscosity 15 cps. Likewise, EC is used with polar and non-polar organic solvents, not soluble if the water exceeds 20% of the total solvent. The typical use level of this binder is 2-10% and it exhibits 5% viscosity 4, 7, 10, 14 and 22 cps (respectively). Similarly, PVP is used with water, hydroalcoholic solvents, and polar organic solvents. Typical use level for this binder is 2-10% and it exhibits 5% viscosity 2, 2.5, and 55 cps (respectively). Lastly, PGS can be used with water only, it also acts as a disintegrant, effective use levels are mostly higher than other binders and the typical use level for this binder is 2-15%. Dürig, T., & Karan, K. (2019) and Yeager, J. et al. (2011).

Transformation of granules into avocado pills using a tablet press

Granule compression (using a Natoli BLP-16 rotary tablet press) is a process performed by punch filling, metering, pre-compression, main compression, tablet ejection, and bottom punch removal. Once the granulated mixture is fed into the die, the dosing stage is adjusted to achieve the dosing position.

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The granule is then locked between the punches (upper and lower) during pre-compression and main compression until ejection of the tablet is achieved. The pre-compression stage is very useful because it removes the air trapped in the die and reorganizes the packaging of particles. Likewise, the main compression stage compacts and, therefore, transforms the granulated powder bed into a tablet. Su, Q. et al. (2019).

Results

Table 2 shows the results of the drying experimentation by the lyophilization method. At the end of the drying process, an amount of avocado powder of 30-35% is obtained in relation to the avocado mass applied in the process. Ramos Solís, R. (2006).

Dehydration time (h)	Humidity %	% protein	% of fat	% fiber	% carbohydrates
2	0.54 (±0.04)	6.1 (±0.5)	66.2 (±0.5)	19.2 (±0.5)	7.8 (±0.5)
3	0.32 (±0.04)	7.6 (±0.5)	64.4 (±0.5)	18.6 (±0.5)	8.9 (±0.5)
4	0.22 (±0.04)	4.8 (±0.5)	63.9 (±0.5)	21.1 (±0.5)	10.2 (±0.5)
5	0.25 (±0.04)	5.9 (±0.5)	61.4 (±0.5)	12.1 (±0.5)	20.1 (±0.5)
6	0.20 (±0.04)	6.4 (±0.5)	61.2 (±0.5)	16.3 (±0.5)	15.7 (±0.5)
7	0.20 (±0.04)	4.5 (±0.5)	60.7 (±0.5)	16.2 (±0.5)	18.2 (±0.5)
8	0.02 (±0.04)	7.6 (±0.5)	61 (±0.5)	17.3 (±0.5)	13.9 (±0.5)
9	0.22 (±0.04)	7.6 (±0.5)	59.7 (±0.5)	15.1 (±0.5)	17.3 (±0.5)
10	0.27 (±0.04)	6.4 (±0.5)	61.1 (±0.5)	16.6 (±0.5)	15.4 (±0.5)

Table 2 Percentage of moisture based on dehydration time
Source: Ramos Solís, R. (2006).

Discussion of results

Optimum dehydration times range from four to six hours, because after six hours of dehydration it would be necessary to apply less heat (less than 20 ° C) to the containers and this would cause the product to become highly hygroscopic. In the same way, if dehydration is handled for one to three hours, it would cause damage to the nutritional and organoleptic properties of the avocado, since it would be necessary to apply more heat (greater than 35 ° C) to the containers. Ramos Solís, R. (2006).

During the granulation process of avocado powder, a technique that can work with heat-sensitive materials is required, because the powder of this fruit requires specific temperature parameters (20-35 ° C) in order not to lose its nutrients. For this reason, FBG and TSG would be the indicated granulation techniques to obtain successful avocado granules. On the one hand, FBG requires low energy requirements when drying the granules and this technique allows controlling the various operating parameters. However, this process requires more liquid solution to form successful granules which could result in wetter and therefore porous granules.

On the other hand, the granules formed by TSG present a higher load of the active principle of the drug, but the mechanism of this technique is difficult to control because any variation in the length, geometry and diameter of the screw could affect the properties of the granules. Therefore, FBG would be the most suitable technique to achieve successful avocado granules, as this process allows control of spray speed, fluidization speed, nozzle position and atomizing air pressure. Likewise, the use of more binder liquid in FBG would not be a key factor in the formation of avocado granules, because dehydrated avocado has very low moisture percentages.

On the other hand, the most indicated binder to use in FBG would be Povidone, since this binder can be used with water, hydroalcoholic solvents and pure polar organic solvents. Using PVP during FBG would be excellent, as this binder features ultra-low viscosity grades and allows high solution concentrations (20%) during the process. Finally, in this study the solid avocado pills would be rectangular in shape due to the design of the rotary tablet press.

Conclusions

In this study, the manufacture of solid avocado pills has been proposed so that the nutrients of this fruit reach all sectors of the world. However, the substitution of the powder of the active ingredient of the medicine for the dehydrated powder of the avocado (in pharmaceutical processes) could present a great challenge for the manufacturers of these pills, due to all the variables and parameters that must be considered to achieve pills. solid successful. For this reason, in this study the use of FBG has been proposed to achieve the correct agglomeration of the avocado powder, because this technique would not alter the final properties of the avocado granules by being able to control the process parameters. Also, the use of Povidone during FBG was proposed, since the properties of this binder are compatible with FBG and, therefore, the use of PVP would allow the obtaining of successful avocado granules during granulation. On the other hand, in this study the use of a rotary tablet press (Natoli BLP-16) has been proposed to obtain solid avocado tablets. However, the avocado granules could be compacted with different compaction presses, for example the TDP 5 tablet press.

This study is consistent with the article "The granulation process: practical experiences" by Capdevila, J. (1993), since granulation allows improving the hygienic quality of the food, less separation of ingredients during the process and easier for the storage and transport of agglomerates. However, this technique has high production costs and, based on the latest poverty measurement in Mexico prepared by Coneval (2018), 52.4 million poor people were registered. Therefore, food granulation as a sustainable and survival means could be a challenge in Mexico. Capdevila, J. (1993) and Lozano, L. (2019).

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Intelligent system for monitoring motor pumps in the water supply to optimize crop rotation

Sistema inteligente para el monitoreo de motobombas en el suministro de agua para optimizar rotación en cultivos

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Abstract

In the agricultural sector of the municipality of Guasave, diesel pumps are currently used to irrigate the various crops, this due to the lack of water that has occurred in recent years. To do this, these pumps are mostly manufactured with very rustic physical structures and only with analog markers that are not very precise. This situation keeps the equipment unprotected and only shows parameters analogically, this makes the process inefficient. With the present project, we designed, developed and simulated a prototype of a system that evaluates and monitors the physical parameters that influence the operation of different thermal machines used for pumping. To achieve the above mentioned, a series of sensors were installed, the signal is sent to Raspberry Pi 3, in which the data is processed, stored and shown to the user of the equipment through a graphic interface. A possible improvement of this system in the future would be to create a mobile application, which in real time, could alert the user of possible failures, decreasing the side effects on the environment, optimizing crop rotation for the continuous improvement of the competitiveness of the agro-industrial sector in northern Sinaloa.

Innovation, Technology, E-learning

Resumen

El sector agrícola del municipio de Guasave, actualmente se utiliza bombas a diésel para poder regar los diferentes cultivos, esto debido a la falta de agua que se ha presentado en los últimos años. Para hacer esto, se fabrican estas bombas en su mayoría con estructuras físicas muy rusticas y solo con marcadores analógicos que son poco precisos. Esta situación mantiene desprotegido al equipo y solo muestran parámetros analógicamente, esto hace ineficiente el proceso. Con el presente proyecto, se diseñó, desarrolló y simuló un prototipo de un sistema que evalúe y monitoreé los parámetros físicos que influyen en la operación de distintas máquinas térmicas usadas para bombeo. Para lograr lo antes mencionado se instalaron una serie de sensores, la señal es enviada hacia Raspberry Pi 3, en la cual son procesados los datos, almacenados y mostrados al usuario de los equipos a través de una interfaz Graphic. Una posible mejora de este sistema en un futuro sería crear una aplicación móvil, que en tiempo real, pudiera alertar al usuario de posibles fallas, disminuyendo los efectos colaterales en el medio ambiente, optimizando la rotación de cultivos para la mejora continua de la competitividad del sector agroindustrial en el norte de Sinaloa.

Innovación, Tecnología, E-learning

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Introduction

In the state of Sinaloa, specifically in the municipality of Guasave, it is common to use diesel pumps to irrigate the different crops that are planted. For this you have pumps, mostly with very rustic physical structures and only with analog markers that are not very precise.

Throughout history, this town has been characterized by promoting the development of agriculture since it is the main economic activity in the region, being known as the agricultural heart of Mexico, that is why over time it has had to look for alternative irrigation systems due to the effect of droughts that have occurred throughout the growing seasons.

There are different irrigation methods which can be used on flat or sloping lands; depending on the land, water availability and harvest; According to these characteristics, they are divided into 3 types of irrigation, as we can see in Figure 1.

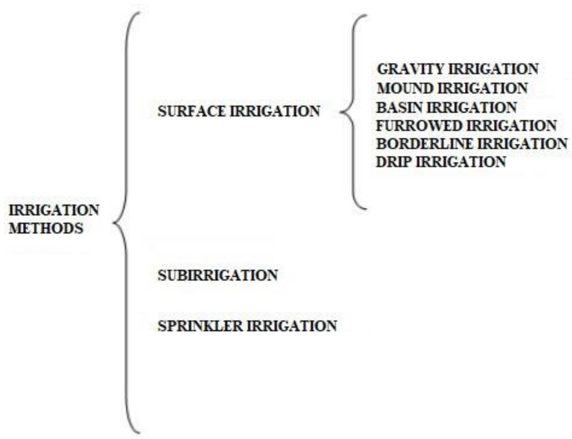

Figure 1 Irrigation methods.
Source: (Delgado, 2010)

Regardless of the irrigation method used, currently some pumps are used to do so, which make it easier to carry water from one place to another. For this, there is a great variety of pumps used to provide the water with the necessary energy to be propelled and reach its destination. Those most commonly used in agriculture are the so-called turbo machines, in which there is an increase in the speed of the water caused by the rotating movement of an element called an impeller or impeller, made up of blades.

Given these conditions and the increase in the use of pumps for the transfer of water, the need arises to create systems that help this activity to be carried out more efficiently, therefore some related research works are presented below. which this work is based on.

In (Escalas Rodríguez, 2014) an automatic irrigation system controlled with Raspberry Pi and Arduino installed by a gardening company is proposed. This system is called REGPI and works based on sensors connected to a microprocessor with an internet connection, this allows the system to be controlled remotely through a web browser, this can be seen in Figure 2.

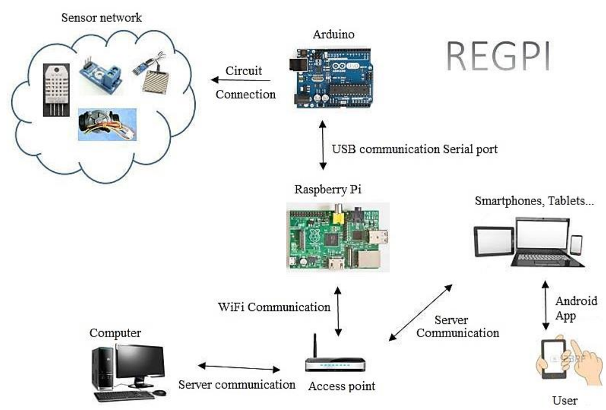

Figure 2 REGPI system operation diagram.
Source: (Escalas Rodríguez, 2014)

(Alamoto Barahona, 2016) present a prototype of a drip and sprinkler irrigation system which is automatic, all this through a remote control device, a web page that allows you to indicate the on and off times of the system, and which also allows storing system information in a database. In Figure 3 we can see the block diagram of this system.

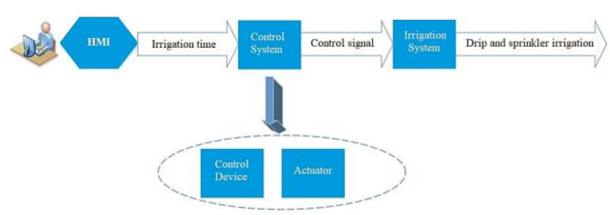

Figure 3 Block diagram of the automated irrigation system
Source: (Alamoto Barahona, 2016)

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In (Ruiz Molina, 2014) a thesis is presented with a topic related to data conditioning, acquisition and storage, taking into account the LabVIEW program and other programs related to signal processing, which makes this work contain valuable information for this project . In this thesis, microcontrollers with USB storage units and a network connection system called Ethernet are used for data collection, on the other hand, the analog signal of the translators of the system to be monitored is adapted to be able to process and save them. The general structure of the system can be seen in Figure 4.

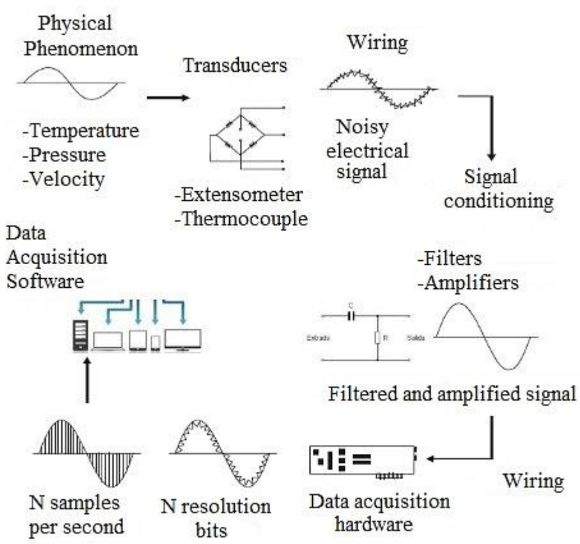

Figure 4 General structure of the system
Source: (Ruiz Molina, 2014)

In Anaya & Ojeda, 2020 they present a thesis that proposes a greenhouse prototype for the cultivation of edible plants, vegetables and fruits in closed environments, in a controlled and automated way. They do this through an Arduino electronic board, the most significant environmental variables that influence plant growth are controlled in an automated way, such as temperature, air humidity, soil humidity and lighting. Likewise, a mobile application was developed, which allows the monitoring and control of the crop or plant inside the greenhouse.

Bosh, 2013 elaborated a thesis that consists of developing an intelligent monitoring system for multilevel inverters, which detects semiconductor faults by only measuring the terminals (states and outputs) of the transistor modules.

Among the specific objectives are the following: To develop a methodology that identifies the instantaneous operating status of all semiconductor modules type H-bridge, three-phase bridge, and NPC bridge. Prepare a protocol that identifies or discards faults, based on the states observed from the outside, in the modules of different bridges. Implement an intelligent monitoring system that identifies or rules out failures in a three-phase bridge inverter, based on the observed states. Develop a graphical interface that displays information regarding the operation and status of the inverter.

Problem Statement

In the municipality of Guasave, agriculture has achieved significant progress over time, with producers using cutting-edge technology for various processes.

Such is the importance of the development that agriculture has at present, which represents 70% of the total area of the municipality, from which several aspects emerge, one is the fact of having 346,441 hectares destined to that economic activity, of which which 181,542 hectares are destined to irrigation. (Municipalities.mx, 2018).

One of the main problems for this activity in recent years and which will worsen in the future, is the lack of irrigation water. As mentioned in (FAO, 2003) to alleviate these problems “proposes a strategy to reinvent water management in the agricultural sector, based on the modernization of irrigation infrastructure and relevant institutions, the full participation of water users. water in the distribution of costs and benefits, and the drive for underinvestment in key sectors of the agricultural production chain”.

For this reason, different irrigation techniques have been used to make the most of this resource. One of these techniques is the use of irrigation pumps, which allow farmers to transport the vital resource to their crops in an easier way.

However, these pumps generally do not have automated systems, which allow monitoring and preventing failures during their operating time.

Given these problems, this project aims to develop a system that allows the user to show accurate readings of the equipment operation, keeping an operation history and through a security module to protect the motor against common failures in the system. On the other hand, this system can be installed on computers that share its problems, even if they are used for different purposes.

The price of installing the equipment would be relatively low considering the benefits it will have for the equipment and therefore the owner and / or user of the same.

That is why this project proposes the realization of the design and simulation of a monitoring and protection system applied to diesel pumps, it is aimed at controlling the operation of an internal combustion engine coupled to a snail-type pump used for crop irrigation. agricultural. The system works by collecting the signals from different sensors installed in the pump and displaying them on the screen and deactivates the equipment if the values provided by the sensors are outside the operating range, protecting it against costly damage, controlling and monitoring the equipment variables can protect it. against failures and avoid downtime and more accurate readings.

The steps to follow to develop the project was to follow an investigation of the operating conditions of the pump, as well as its operating characteristics. On the other hand, a series of options was investigated to choose the most suitable software and hardware to carry out the project, evaluating different options and thus moving on to the design and simulation of the monitoring system, the design was carried out on the Raspberry Pi and the simulation on a Windows PC given its software compatibility. Finally, the system was applied to the equipment operating in the real field and evaluating its performance.

The development of the project led us to obtain a design and simulation of a prototype with a multiplatform application in the Python language that can be executed on Linux and Windows operating systems, in addition to obtaining simulated data and randomly generated by a microcontroller.

A prototype was used to simulate the switching on and off the pump by means of a relay having a response of the correct operation of the system in addition to the real field tests carried out.

State of the art

Monitoring systems are indispensable in industries, where they can be implemented to optimize available resources. For example, the processes necessary to give proper use to water in hydraulic supply systems, consumption centers or discharges, among others, where it is necessary to measure and / or keep constant some quantities, such as the pressure of a line, the level of a cistern or the instantaneous expense in a pumping station, among other variables.

Monitoring generally means being aware of the state of a system, to observe a situation of changes that may occur over time, that is, there is no manual or automated question about the control of variables, it is only the visualization of the changes in instrumentation according to system conditions; This monitoring can be carried out with the personnel and their tools in hand, or with the automatic intervention of the instrumentation equipment integrated with transmission devices through local or remote networks, which send information to a monitor or to an administration panel of the variables.

Automation is the application of automatic machines or procedures in the performance of a process or in industry. The goal of automation is to generate as much product as possible in the shortest time possible. Automation can be applied in many industries including textiles, electronics, food, automotive and agriculture.

The latter as the most important for our region, specifically in irrigation, which constitutes various procedures that allow the efficient distribution of water on the soil surface, where the implementation of new technologies will allow us the opportunity to attend a time where automation will be massive. Planting, irrigation, maintenance, surveillance, control and even harvesting will be automated. (Agricultural ERP, 2016)

Regardless of the industry where it is applied, an automated system is made up of different components, among which stand out, the instrumental part, the sensors, the control software and the communication systems.

Instrumentation is a set of instruments necessary to carry out an activity or reach a solution, this allows us to measure variables of matter in its different states, gases, solids and liquids, hydraulics and pneumatics provide us with the necessary force to move motors or servomotors, which are in charge of the dynamics in automation, as well as to move a pump, press or move an object (Torres Montero, 2015). Within the instrumentation we can find different components such as:

A Water Pump or Motor Pump is a piece of equipment that has the same operation as any hydraulic pump. They are teams that transform Mechanical Energy into Kinetic Energy. That is, in the end it is necessary to generate a movement of the liquids that are to be used. When the pump receives that energy with a coupled motor, be it Gasoline or Diesel, the Water Pump is called a Motor Pump, if the energy is by electric current it is called an Electric Pump. The power they develop and the characteristics of their cooling systems allow long-term use. Some advantages and disadvantages of these are (Ventageneradores, 2016):

Advantage:

- It does not require contracts or supply companies.
- It does not require paying for the installed power that you have.
- There are no surcharges.

Disadvantages:

- It is not a system with full autonomy, due to the fuel used.
- They are louder systems.
- They have a relatively higher initial and maintenance cost.
- In most cases they do not allow automation.

A sensor is a device that measures, automatically or directly, a variable and provides an output signal, which is a function of the variable to be measured. There is a great variety of sensors, depending on the magnitude to be measured and the characteristics that they want to have, as well as their application (Corona, Abarca, & Mares, 2014). These tell us what is happening in the processes, where you are at a certain time and send a signal that allows you to continue with the next process. Some examples of sensors can be:

Pressure sensors or pressure transducers are very common in any industrial process or test system. Their objective is to transform a physical quantity into an electrical one, in this case they transform a force per unit area into a voltage equivalent to that exerted pressure (Araya, 2009).

Temperature sensors are devices that transform changes in temperature into changes in electrical signals that are processed by electrical or electronic equipment (Corona, Abarca, & Mares, 2014).

RPM sensors base their operation on the electromagnetic phenomenon, that is, the relationship between magnetism and electricity. When a coil is subjected to the variation of a magnetic field, an alternating electric current is produced in it, produced by the effect of magnetic induction. It is responsible for informing the momentary revolutions of the engine. It is composed of a coil wound on a magnetized core (Guarella, Heredia, Rodríguez, & Bagatto, 2011).

On the other hand, there are the control and communication systems, which are composed of both software and hardware, these link all the parts and the logic controllers, they are in charge of controlling that everything has a sequence, making decisions according to a established schedule. Within this category we find components such as:

Arduino is an open electronics platform for prototyping based on flexible and easy-to-use hardware and software. It can take information from the environment through its input pins from a whole network of sensors. In this case, Arduino will be controlled by the Raspberry Pi (Escalas Rodríguez, 2014).

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Raspberry Pi is a low-cost computer and consists of a motherboard on which a processor, a graphics chip and RAM are mounted. As for the operating system, several can be installed, most of them based on the Linux kernel. (Rodríguez Scales, 2014)

To do all the software part, there will be two programming tools such as the Arduino IDE and Python. IDE stands for "Integrated Development Environment". This IDE was installed on our computer, and it is a very simple environment to use and in it the program for the Arduino component was written. (Martínez, 2015)

Python is a powerful and easy-to-learn programming language. It features efficient, high-level data structures and a simple but effective approach to object-oriented programming. (Santana Roldan, 2013)

Methodology

The methodology to be followed will be based on the specific objectives of the project, and will be shown in (Escalas Rodríguez, 2014), starting from a field investigation, where the phenomenon was studied directly, and from this study, defining the requirements that the proposed monitoring system would have.

In Figure 5 you can see a block diagram of the activities carried out.

Figure 5 Block diagram of the project.
Source: Own elaboration, (2019)

Field study

For the field study, a survey was conducted of 100 people related to agricultural activity such as farmers, SAGARPA staff, as well as experts from the agricultural area, this in order to know what is the utility that is given to the equipment pumping and how careful they are with such equipment. In addition, it also served to know what are the costs of carrying out repairs on the pumping equipment used in the region, as well as the costs of a new equipment.

In the same way, the physical characteristics of the motor pumps used for irrigation in the region were studied, of which it was mainly identified which variables were of interest in their monitoring both for the equipment itself and for the user.

Likewise, it was studied how the different parameters are currently measured, the types of sensors used by the motor pumps, if they used them, and how they could be measured for use in this project.

For this, visits were made to different producers that had irrigation motor pumps, as well as the facilities of the Association of Agricultural Producers Users Petatlán Module II-1 A.C., and thereby collect the necessary information.

Monitoring system design

Once the field study was carried out, the system requirements were identified in terms of hardware and software aspects.

At this point, an exhaustive search was carried out for possible sensors that were adapted to the project, mainly according to their physical characteristics, operation and cost. Based on these characteristics, the best options were chosen.

The temperature sensor chosen was a type k thermocouple, this given its characteristics made it ideal for our purpose. The 1G / 4 pressure sensor with a 174 Psi range given its cost and durability.

The same was done for the software, the possible programming languages that fit with the different hardware parts were studied, without the need to raise the cost of the prototype, which should preferably be free software languages.

Several programming languages and tools were tested, leaving in the end the options of MyOpenLab due to its versatility in this type of application, as well as the Python programming language, which due to the characteristics of the native operating system of the Raspberry Pi, made it ideal for this Proyect.

Based on the analysis that was carried out, a design of the monitoring system was carried out, in this design the two main aspects in which it is proposed to divide the project were considered, such as the hardware part and the software part.

This design should allow the sensors to send signals to the Arduino and Raspberry Pi modules, so that they could be processed and display the different measurement parameters on a screen for the operator and at the same time a history of the parameters obtained during operation was saved. equipment, and a system to protect the equipment against operating errors had to be programmed.

In Figure 6 you can see the design proposed for the proper functioning of the monitoring system.

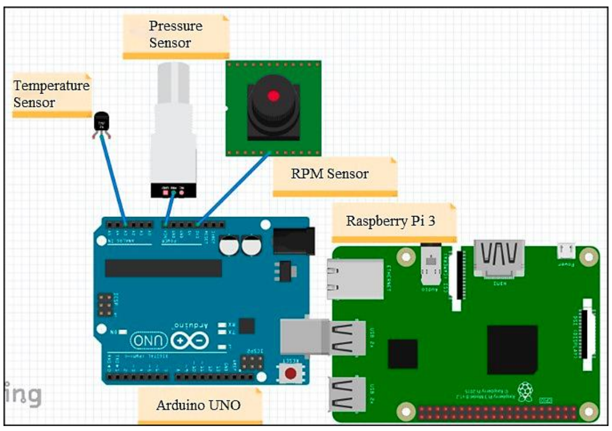

Figure 6 Physical diagram of the prototype
Source: Own elaboration, (2019)

In addition, as the system had to be installed in the pumping equipment, the design of a cabinet was also made, which contained the display screen and the Arduino and Raspberry components inside, this design is shown in Figure 7.

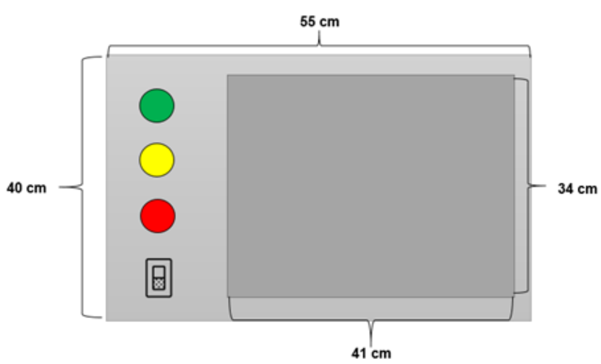

Figure 7 Designed Cabinet Dimensions.
Source: Own elaboration, (2019)

Prototype development

Once the software and hardware requirements had been established, in addition to verifying the shape of the monitoring system cabinet, the development of the prototype as such was carried out.

The first of the activities carried out was to test the sensors, here the necessary connections were made with the Arduino module, according to the design, this was used as a data acquisition card. It performed the function of an analog to digital signal converter, in addition to serving as a means of protection between the devices and the Raspberry Pi, in the event of an electrical failure, thereby ensuring that the data stored by the system would be protected. The Arduino module was used since the Raspberry Pi does not have analog inputs, and as mentioned above the sensors provide us with analog signals.

Once the signals were converted to digital in the Arduino device, it sent the measurements from the sensors to the Raspberry Pi, through serial communication, through a USB connection.

Received the data in the Raspberry these were processed and displayed on the screen. All this through an application developed in Python. It was more viable since, in addition to being free software, the applications created with it are multiplatform, that is, they can be run on almost any computer and on any operating system without any problem.

All the data received is stored in a text file, this for later consultation, with which the behavior of the equipment during its operation could be studied, and in case of failures, it can be possible to locate when they were and what failed.

In addition, the monitoring system has a protection system, where in case of detecting measurement parameters of the sensor signals, it automatically stops the equipment, this in order to prevent failures and breakdowns of the different components of the equipment. pumping. Some of the failures can be high or low oil pressure, high temperature, dry work, that is, the equipment is not pumping water or any liquid, among others.

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Simulation

The Python application is cross-platform, this means that we can run it on both Windows and Linux, that is why the simulation tests were done on a Windows computer, but with the same application that was run on the Raspberry Pi.

First, Arduino was programmed with a special code for random data using the “random” instruction, this is used for random numbers within a certain range, which can be configured in the code. For this we established the ranges of the variables according to the readings in which this type of equipment can be handled.

In addition, the operation of the Arduino was simulated by means of a simulation software called MyOpenLab, this software is multiplatform, for this reason it can be run on the Raspberry Pi and on a computer, for this we use Arduino as a data acquisition card, programming it from the software to enable or disable outputs on the Arduino.

The programming is done through a library called "Firmata", which is loaded into Arduino and links it to the software, then the inputs and outputs of the Arduino are activated from the software.

Then, the programming of the inputs from which the signal was received is done and all kinds of operations are done to manipulate the output that was activated from the Arduino. In Figure 8 we can see the programming carried out and the final interface.

During these simulations, an LED lamp was turned on and off, which served as the system pump.

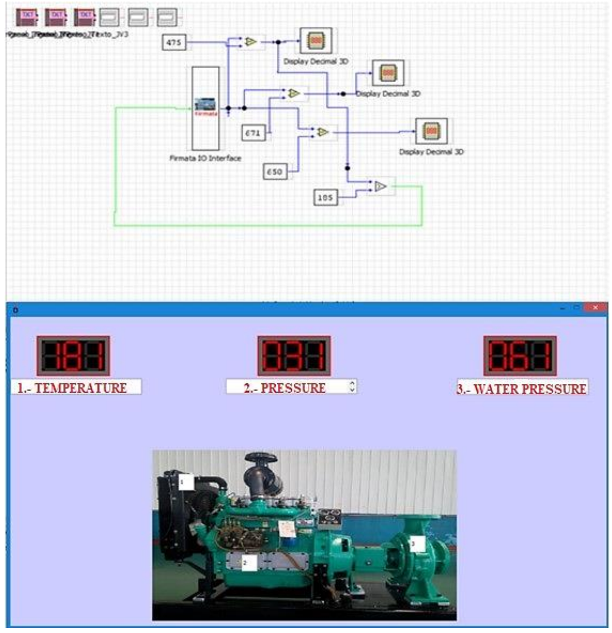


Figure 8 Interface programming in MyOpenLab.
Source: Own elaboration, (2019)

Field tests

In this part of the methodology, the monitoring system was applied in a real environment, the pressure and temperature sensors were installed in a pumping equipment. This equipment was loaned by the Petatlán Guasave irrigation module, and was carried out on the banks of the Sinaloa River. The pump used for the field tests can be seen in Figure 9.

Figure 9 Pumping equipment with the prototype installed.
Source: Own elaboration, (2019)

The water pressure sensor could not be installed as the owner did not have permission to modify the physical structure of the centrifugal pump coupled to the motor.

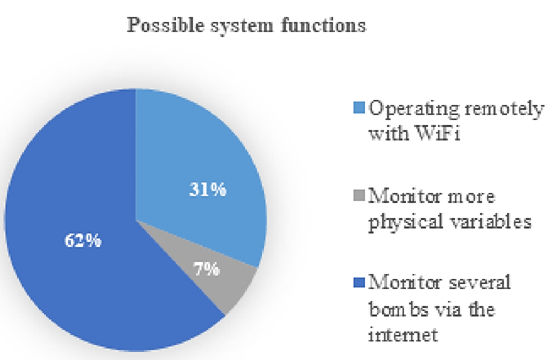
Finally, the monitoring project was applied to another type of diesel engine, such as the Yanmar Thermo King 2.35 engine, which is shown in Figure 10.

Figure 10 Yanmar engine used for testing.
Source: Own elaboration, (2019)

Results

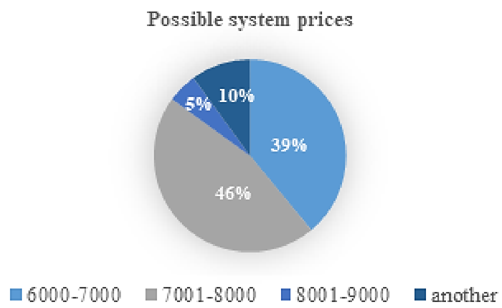
According to the activities carried out during the project period, different results could be obtained:

First, qualitative information was obtained from the surveys of users and experienced personnel in the area. In Graph 1, we can see that, as a result of one of the questions in the survey, people gave their opinions about possible new functionalities that this project could have, to which 62% believed that the best option would be to link several pumps through the use of the internet.



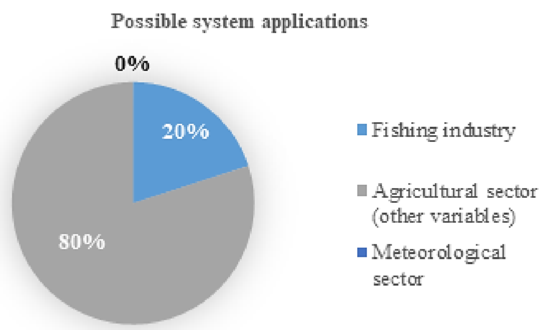
Graphic 1 Results of possible system functions.
Source: Own elaboration with information collected in surveys carried out, 2019)

In the same way, respondents were asked about the prices they would be willing to pay for the system, to which 56% responded that the price to pay could range between $ 7,000 and $ 8,000 pesos, as can be seen in the Graphic 2.



Graphic 2 Results of possible system prices.
Source: Own elaboration with information collected in surveys carried out, (2019)

In addition, it was also asked about other applications that could be given to the system, this in order to expand the target market, to which 80% of the respondents answered that another application could be the aquaculture sector, as observed in the Graphic 3.



Graphic 3 Possible system applications.
Source: Own elaboration with information collected in surveys carried out (2019)

Tests were also carried out on the hardware components, mainly on the sensors, for which it was possible to corroborate that they gave real measurements, for which, the measurements obtained in the system were compared with commercial meters of the different parameters, showing very good results. similar, we can see this in Figure 11, where pressure and temperature readings obtained in the system are shown, and those obtained in a pressure gauge and a digital infrared thermometer, where the pressure reading approaches 50 psi and the temperature at 25 ºC.

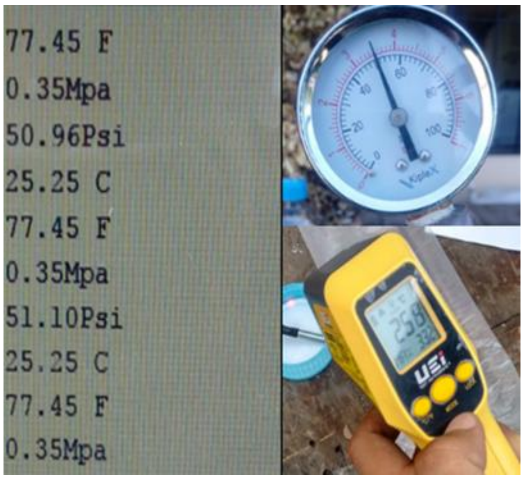


Figure 11 Comparison of measurements between the system and commercial meters.
Source: Own elaboration with tests carried out (2019)

Once the hardware components were tested, tests were carried out to be able to choose the best Graphic interface for the system, this through different programming languages, in Figure 12, we can see different designs made both in MyOpenLab, and in Python.

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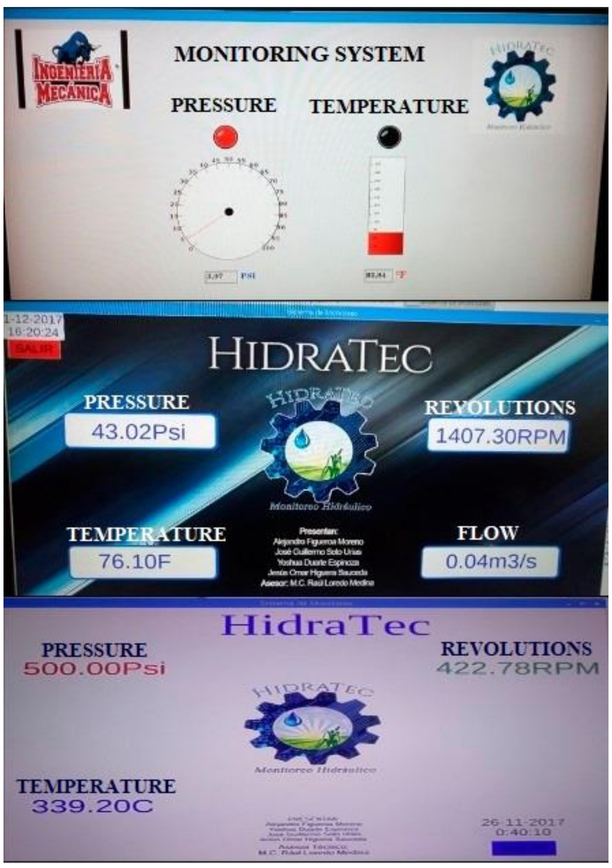

Figure 12 Graphic interface tests of the system.
Source: Own elaboration with tests carried out (2019)

In Figure 13 the final prototype of the system is shown, you can see the cabinet installed in the motor pump where the field tests were carried out, these were carried out in the facilities of the Guasave-Petatlán II-1 Irrigation Module, on the banks of the River Petatlán. In these tests, the system was left running for a certain time to observe how the measurements varied..

Figure 13 Monitoring system in field tests
Source: Own elaboration with tests carried out (2019)

Finally, it should be mentioned that in the field tests it was not possible to test the protection system, since if the motor pump failed, it put the equipment at risk, and for safety reasons, the company asked us not to do it. . However, a simulation of the protection system was carried out, for this, threshold data was established for each monitored parameter, which are, temperature greater than 185 ° F, oil pressure less than 55 PSI and water pressure less than 25 PSI Once these thresholds were passed, the application through Arduino ordered the system to turn off, which in this case was simulated by a lamp which was connected to a relay.

Conclusions

Climate changes currently have meant that food production processes, specifically in agriculture, are also modified. With these changes, it is increasingly common to see the use of new tools, which help to automate these processes, with the help of new technologies.

For this reason, in this work the design and development of a monitoring system was carried out, which automatically allows obtaining measurements in real time of different parameters of interest in the operation of pumping equipment, in this case diesel motor pumps. , and according to these measurements to be able to detect possible failures or malfunctions and make the equipment stop automatically, which can prevent expenses for repairs or purchases of new equipment, which would involve savings in both time and money for users of this type of equipment.

According to the results obtained both in the simulations and in the field tests, we can conclude that the developed prototype is functional. In addition, this same prototype can be used in applications where equipment with similar operations is handled, and parameters can be added, depending on the purpose of the same.

As work in the future, it is proposed to extend the time to carry out field tests, and to try to find moments in which equipment failures occur, to verify if the monitoring system is capable of detecting it, since, for reasons of Logically, the equipment used for these tests was impossible to make them fail, since they belonged to a company external to us. Also, it is proposed to make a mobile application, which is connected to the monitoring system, with which messages can be sent to the operator and / or user of the equipment, where they can observe or monitor the equipment, in any place where be found.

Acknowledgments

We thank the Association of Agricultural Producers Users Petatlán Module II-1 A.C., for having lent us their facilities and equipment to be able to carry out the tests carried out on the prototype resulting from the project.

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Safflower seed (*Carthamus tinctorius* L.) invigoration by pre-hydration

Vigorización de semilla de cártamo (*Carthamus tinctorius* L.) mediante pre – hidratación

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Abstract

For seed storage, a low moisture content index is recommended, while in sowing, a rapid and homogeneous hydrolysis is important to reactivate its metabolism during germination and seedling development. The goal of the study was to establish the effect of pre-conditioning treatments on safflower seed, through the germination and emergence of seedlings. The pre-imbibition treatments were: distilled water, gibberellic acid and a biostimulant based on humic and fulvic acids, in periods of 2, 4, 6 and 8 hours. The seed was produced in spring-summer 2019 and 2020. The results indicate that imbibition of seeds in water by a period of 4 hours was the most effective treatment, showing the highest germination percentages, in addition to presenting a faster and more uniform emergence of seedlings. The pre-conditioning with Gibberellic acid even reduced the germination values and the biostimulant generated homogeneity in the emergence of seedlings

Pre conditioning, Safflower seed, IVE

Resumen

En el proceso de conservación de semilla, un bajo índice del contenido de humedad es recomendable, mientras en la siembra, es importante una hidrólisis rápida y homogénea que reactive su metabolismo durante la germinación y desarrollo de plántulas. El objetivo del trabajo, fue establecer el efecto de tratamientos de pre-acondicionamiento en semilla de cártamo, a través de la germinación y emergencia de plántulas. Los tratamientos de pre imbibición fueron: agua destilada, ácido giberélico y un bioestimulante a base de ácidos húmicos y fúlvicos, en periodos de 2, 4, 6 y 8 horas. La semilla fue producida en primavera-verano 2019 y 2020. Los resultados, indican que la imbibición en agua fue el tratamiento más efectivo mostrando los porcentajes de germinación más altos, además de presentarse una más rápida y uniforme emergencia de plántulas, imbibiendo la semilla en un periodo de 4 horas. El pre acondicionamiento con ácido Giberélico, redujo incluso los valores de germinación y el bioestimulante generó homogeneidad en la emergencia de plántulas.

Pre acondicionamiento, Semilla de cártamo, IVE

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Introduction

Seeds are morphologically and structurally equipped organisms to survive and regenerate. They remain viable, with their metabolism suspended to a minimum, until the time and conditions are right to establish the next generation; however, like any other life form, they cannot retain their viability indefinitely and eventually deteriorate and die. Fortunately, neither nature nor agricultural practice normally requires seeds to survive longer than the following growing season, although the seeds of most species can survive much longer under the right conditions (Copeland y Macdonald, 1995).

In the embryo of orthodox seeds, upon reaching physiological maturity, a period of water loss begins, and tissue solidification until reaching a state called desiccation. This condition is acquired mainly by the presence of LEA (Late Embryogenesis Abundant) proteins that accumulate abundantly in dry seed and vegetative tissues when plants are exposed to water-limited conditions (Cuevas-Velázquez and Covarrubias-Robles, 2011).

The metabolic reactivation of the seed, through the germination process, consists of three stages: a) absorption of water, known as imbibition, b) enzymatic activation, increased respiration rate and assimilation, which indicate the synthesis and transformation of reserves stored and their transposition to the growing areas and c) enlargement and absorption of nutrients already synthesized towards the embryo and cell divisions that result in the protrusion of the radicle and plumule (Baskin, 1998).

The absorption of water or hydrolysis, is a physical process determined by the gradient of water potential and is the most important factor that triggers the germination process. Its efficiency is determined by the absorption capacity of the chemical components of the seed, the permeability of its covers and mainly by its capacity to hydrolyze.

The hydration-dehydration technology proposed by Sánchez *et al*., (1999) which consists of hydrating the seed in order to standardize the moisture content, without reaching the second stage of germination; said treatment was applied to revitalize *Leucaena leucocephala* cv. Cunningham where it was shown that its effectiveness depended not only on its characteristics, but also on the degree of maturity and physiological age, since the aged and fresh seeds showed different demands with this technique to give a positive response (Sánchez *et al*., 2005).

The safflower crop (*Carthamus tinctorius* L.) belonging to the Asteraceae family, is the most widely sown oilseed in Mexico. The main characteristic is that it has an oil content of 37 to 41% and depending on the type of variety it can have 75% oleic acid and 12% linoleic or 75% linoleic acid and 12% oleic. The production of its crop has presented ups and downs, this variation is mainly due to the prices of wheat that is sown in northwest Mexico since they are competitive crops in autumn-winter (Montoya, 2010). Despite the interest in the crop, there are still difficulties related to proper crop management practices, mainly due to the physiological dormancy of freshly harvested safflower seeds (Mayerhofer *et al*., 2011) Dormancy is an innate property of the seed to inhibit or delay germination, allowing them to germinate only under fairly restricted physical environmental conditions (of water, temperature and oxygen) (Baskin and Baskin, 2004). It is an evolutionary adaptation that prevents seeds from germinating during unsuitable ecological conditions that would typically lead to a low probability of seedling survival. However, in cultivated species, it is an undesirable characteristic as it prevents a rapid and homogeneous emergence of seedlings.

In seed of species that ordinarily can present dormancy periods, this can even be induced under certain storage conditions. Another important factor that determines a good seed performance during sowing is the degree of deterioration, which is defined as a series of degenerative changes that involves physical and chemical changes in the internal structure of the seeds. During storage, different mechanisms of deterioration can result in a decrease in the percentage of germination, such as seedling growth speed and tolerance to adverse conditions (Bradford, 1990).

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The objective of this study was to determine the effect of pre-conditioning, with water, gibberellic acid and a biostimulant based on humic and fulvic acids, on the physiological reactivation of safflower seed.

Materials and methods

The work was developed in the seed analysis laboratory of the University Center for Biological and Agricultural Sciences (CUCBA) of the University of Guadalajara. Safflower seed produced in the 2020 w / v cycle and stored seed from the w / v 2019 cycle were used, both produced in Ameca, Jalisco. Mexico.

Pretreatments used:

Treatment 1. Distilled water at a constant temperature of 23 °C.

Treatment 2.50 mg L^{-1} solution of gibberellic acid (ACTIVOL).

Treatment 3.200 mg L^{-1} (pH 7) solution of biostimulant based on humic and fulvic acids with a pH 7

A total of 400 seeds divided into 4 repetitions of 100 were analyzed for each treatment, the seeds were soaked in beakers covering up to 3 cm on the volume occupied by the seed, for periods of: 2, 4, 6 and 8 hours respectively. Subsequently, the surface water was eliminated by placing the seeds on absorbent towels and they were stored in refrigeration at 10 ° C for one week.

The germination evaluation was carried out using the method between paper as substrate according to the rules (ISTA, 2017). Four repetitions were used per treatment, the seed was incubated at 25 ° C for 7 days. Determining, the number of normal seedlings, abnormal seedlings and dead seeds was determined (considering normal seedlings as the percentage of germination.

In the evaluation of the emergency speed index IVE. Four replicates of 100 seeds were used. The seeds were sown in beds of sand, previously moistened, under greenhouse conditions, irrigation applied every other day. The daily seedling emergence count was carried out.

To determine the IVE, the formula proposed by Maguire (1962) was used, considering as the first day that on which the first seedling was observed. Counting continued until 12 days after sowing. The following formula was used:

$$IVE = \sum_{i=1}^{n} \frac{X_i}{N_i} \quad (1)$$

Where: IVE = emergency speed index; Xi = number of seedlings emerged per day; Ni = number of days after sowing; n = Number of counts 1, 2... n counts.

A factorial design of three factors was used in completely randomized with four repetitions. A first factor is seedlots, a second factor is pre-soak treatments, and a third factor is soak times. Prior to the analyzes, the germination percentage values were transformed using the arc-sine vX / 100 function. An analysis of variance was carried out and comparison tests of means were carried out (Tukey, 0.05). The statistical analyzes were run with the statistical package SAS version 9.3

Results

Variation sources	g.l.	Germination (%)	IVE
Lot	1	2399.20 **	872.90 **
Preimbibition treatments (PT)	2	848.40 **	80.39 **
Imbibition times (IT)	3	175.44 **	13.78 **
Lot * PT	2	0.74 ns	42.75 **
Lot * IT	3	7.70 *	18.23 **
TP * IT	6	115.62 **	23.71 **
Lot * PT * IT	6	35.21 **	5.82 **
C.V.		2.48	9.06
Mean		77.53	11.58
C.V. = Coefficient of variation; IVE = Emergency speed index. *, ** = significant with p ≤ 0.05 and with p ≤ 0.01, respectively; ns = Not significant			

Table 1 Mean squares and statistical significance of the effect of preimbibition treatments and different imbibition times in safflower seeds.

The analysis of variance (Table 1) showed that at the source of variation lot, the preimbibition treatments and the imbibition times showed highly significant differences ($p \leq 0.01$) both in germination and in the emergence speed index (IVE). Regarding the interactions of the sources of variation, with the exception of the interaction lot* preimbibition treatments that did not show significant differences and the interaction lot* times of imbibition that presented significant differences ($p \leq 0.05$), all other interactions showed highly significant differences ($p \leq 0.01$).

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The coefficients of variation are relatively low (≤ 9.06%), which shows the reliability of the results in the analysis of variance.

Lots	Germination	Emergency speed index (IVE)
Lot 1 (2019)	70.60 b	8.5 b
Lot 2 (2020)	84.45 a	14.6 a
DMS	0.85	0.4
Mean	77.53	11.5
DMS = Minimum significant difference. Means with the same letter are statistically similar (Tukey, 0.05)		

Table 2 Comparison of Tukey means of germination and emergence speed index of safflower seeds based on the seed lots evaluated

The comparison of Tukey means based on the seed lots evaluated (Table 2) showed that lot 2 had a higher germination percentage of safflower seeds (84.45%) than lot 1 (70.60%). Similarly, the emergency speed index (IVE) had the highest value in lot 2 (14.6) and the lowest value in lot 1 (8.5).

Preimbibition treatments	Germination (%)	Emergency speed index (IVE)
Distilled water	82.56 a	13.09 a
Gibberellic acid 50 ppm solution	69.28 c	9.93 c
200 mg L-1 solution of humic acids	80.75 b	11.72 b
DMS	1.25	0.62
Mean	77.53	11.58
DMS = Minimum significant difference. Means with the same letter are statistically similar (Tukey, 0.05)		

Table 3 Comparison of Tukey means of germination and emergence speed index of safflower seeds based on the preimbibition treatments evaluated

The comparison of Tukey means based on the evaluated preimbibition treatments (Table 3) showed that distilled water had a greater response in the germination percentage of safflower seeds with 82.56%. Similarly, in the speed index of emergency (IVE) water had the best response with a value of 13.09.

Imbibition times	Germination (%)	(IVE)
2 hours	75.12 c	11.13 b
4 hours	82.25 a	12.71 a
6 hours	75.66 bc	11.33 b
8 hours	77.08 b	11.16 b
DMS	1.59	0.79
Mean	77.53	11.58
DMS = Minimum significant difference. Means with the same letter are statistically similar (Tukey, 0.05)		

Table 4 Comparison of Tukey means of germination and emergence speed index of safflower seeds based on the evaluated imbibition times

The comparison of Tukey means based on the evaluated imbibition times (Table 4) showed that the 4-hour time had the highest response in the percentage of germination of safflower seeds with 82.25%. Similarly, in the index of emergence velocity (IVE) the imbibition time of 4 hours had the best response with a value of 12.71.

The highest germination values were presented in the recently harvested seed lot, likewise, a better and faster emergence of seedlings was obtained using water, these results coincide with Pérez et al. (2016), who found higher germination percentages and development of tomato seedlings (*Solanum lycopersicum*) in seed prehydrated with water. In turn, Sánchez et al. (2001), called this procedure seed ecotechnology, establishing that the effectiveness of water treatments to increase and accelerate the emergence of seedlings is not only due to the activation of metabolic events related to the phase pregerminative, but also profound biochemical-physiological changes that induce tolerance of plants to environmental stress, experienced during stage I of germination in the field.

Conclusions

Preconditioning with water for 4 hours increases the percentage of safflower seed germination and the vigor of seedlings.

Safflower seed preimbibition, using according to the results of Table 3, distilled water was the one that showed the best response in accelerating the emergence speed, followed by humic and fulmic acids., accelerates the speed of emergence in the establishment of seedlings.

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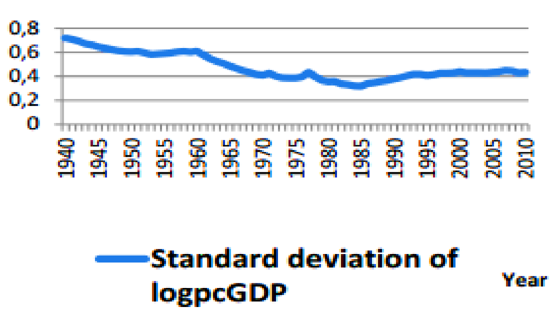

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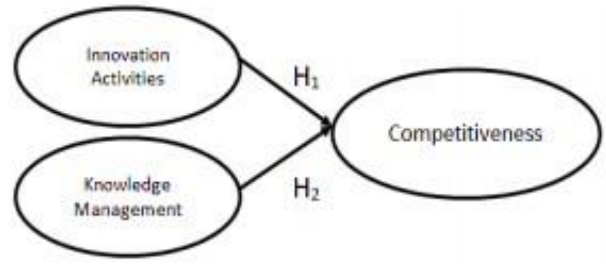

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