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The works must be unpublished and refer to topics of Engineering, Chemical, Optical, Resources, Food technology, Anatomy, Nutrition and other topics related to Medicine and Health Sciences.

Presentation of the Content

In the first chapter we present, *Spectroscopic analysis of organic materials susceptible to transformation processes*, by MORENO-MARTINEZ, Beatríz Eugenia, RAMIREZ-SALAS, Virginia, ZAVALA-ARCE, Rosa Elvira and GONZALEZ-SANCHEZ, Cielo Vanessa, with adscription in the Instituto Tecnológico de Nuevo León, Instituto Tecnológico de Ciudad Madero, Instituto Tecnológico de Toluca, as the following article we present, *Salivary Flow and ph in pregnant patients*, by CAPETILLO-HERNÁNDEZ, Guadalupe Rosalía, OCHOA-MARTÍNEZ, Rosa Elena, TORRES-CAPETILLO, Evelyn Guadalupe and TIBURCIO-MORTEO, Leticia, with adscription in the Universidad Veracruzana, as the following article we present, *Ultrafine particle dispersion in the metropolitan area of Guadalajara, Mexico*, by PEÑA-GARCÍA, Laura, ROBLES-MURGUÍA, Celia, MACIEL-FLORES, Roberto and ROSAS-ELGUERA, José, with adscription in the Universidad de Guadalajara, as the last article we present, *Spectroscopic and thermogravimetric studies of homogeneous materials from PU/PMMA/SiO₂*, by RAMÍREZ-SALAS, Virginia, ORDOÑEZ-PACHECO, Luis Daniel, ALARCÓN-RUIZ, Erika and MORENO-MARTÍNEZ, Beatriz Eugenia, with adscription in the Instituto Tecnológico de Ciudad Madero, Instituto Tecnológico de Nuevo León.

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Spectroscopic analysis of organic materials susceptible to transformation processes

Análisis espectroscópico de materiales orgánicos susceptibles a procesos de transformación

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Abstract

Carry out a spectroscopic study of various materials of organic origin, specifically residues from various processes, both biological and agro-industrial, in order to study their structural characteristics in their main functional groups, since their nature can determine the viability of a process of recycling to obtain new products. Some of the organic materials studied were of great importance because these materials can be susceptible to transformation through various processes such as thermochemical, biological, and biochemical transformation. Leaf samples from the Moringa plant (Moringa Oleifera), orange peels (Citrus sinensis), as well as leachate from the vermicomposting process of the Californian red worm (Eisenia foetida) were analyzed. The results obtained indicate a different composition, but in turn, show similarity in some specific bands, such as carboxylic acids, OH groups, methyl groups, as well as some aromatic groups in the case of citrus fruits. The importance of this research lies in the fact in the study of the transformation processes of these wastes, for future applications.

Resumen

Realizar un estudio espectroscópico a diversos materiales de origen orgánico, específicamente residuos de diversos procesos, tanto biológicos como agroindustriales, con la finalidad de estudiar sus características estructurales en sus grupos funcionales principales, ya que la naturaleza de ellos puede determinar la viabilidad de un proceso de reciclaje para la obtención de nuevos productos. Algunos de los materiales orgánicos estudiados fueron de suma importancia, debido a que estos materiales pueden ser susceptibles de transformación mediante diversos procesos tales como transformación termoquímica, biológica, y bioquímica. Se analizaron muestras de hojas de la planta de Moringa (*Moringa Oleifera*), cáscaras de naranja (*Citrus sinensis*), así como lixiviado del proceso de vermicompostaje de la Lombriz roja californiana (*Eisenia foetida*). Los resultados obtenidos señalan una composición diferente, pero a su vez, muestran similitud en algunas bandas específicas, tales como ácidos carboxílicos, grupos OH, grupos metílicos, así como algunos grupos aromáticos en el caso de los cítricos. La importancia de esta investigación, radica en la viabilidad de poder n el hecho en el estudio de los procesos de transformación de estos residuos, para futuras aplicaciones.

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Introduction

Biomass is a removable resource that currently has multiple applications. There are numerous biomass classifications, but the most accepted, and based on their composition, origin, and state are the following types: a) Depending on their composition: they can be oleoginous, lignocellulosic, b) depending on their origin, it can be natural, residual or from energy crops and c) depending on its state, it can be solid, liquid or gaseous. In this research work, three types of organic materials susceptible to transformation were analyzed, whether biological, thermochemical and chemical, these are: orange peels, moringa leaves and worm castings in their solid and liquid form. [1]

From various thermal, chemical and / or biological processes, biomass of lignocellulosic origin can be transformed into: a) heat energy, b) electrical energy, c) biogas, d) bioethanol, e) biodiesel, f) bioturbosin, g) chemicals with different levels of oxygenation. In particular, the pyrolysis process of lignocellulosic biomass generates three products: i) synthesis gas, ii) bio-oil and iii) biochar. Biochar is an organic material with a high carbon content and that is classified as a multifunctional material with various applications, among which is its use as an organic soil additive. In this section. [3]

The residual organic matter plays an important potato in aspects such as recycling, if the residual organic matter is transformed, the polluting agents are reduced. The use of organic waste would solve many environmental and social problems, because its transformation would generate jobs.

Currently, in terms of waste utilization through the vermicomposting process, more than half of the organic matter in municipal waste is wasted and goes to landfill. Only 19% of the part that receives some treatment is collected separately and therefore produces a quality compost. The production of earthworm humus is obtained by the well-known vermiculture technique that allows to take advantage of and transform almost all organic solid waste derived from agricultural, livestock, agro-industrial and urban activities. They are also known as: vermicompost, vermicompost, and so on.

It should be noted that the cultivation of worms requires very low costs and that the fertilizer produced by these has been increasing in its use, as it is a source of slow-release nutrients in the soil, which implies a considerable economy of agricultural fertilizers and of labor, guaranteeing the necessary balance in the phases of strong demand of the plant.

The objective of this research was to collect the different types of biomass, such as moringa leaves, which may have important functional groups that make it a possible coagulant agent to eliminate particles suspended in water, lignocellulosic residues such as orange peels. in order to obtain fibers and worm humus, as well as to carry out an Infrared Analysis by Fourier Transform (FTIR) study in order to consider possible subsequent uses by virtue of their main functional groups. Figure 1 shows the different chemical structures that moringa oleifera presents. [4]
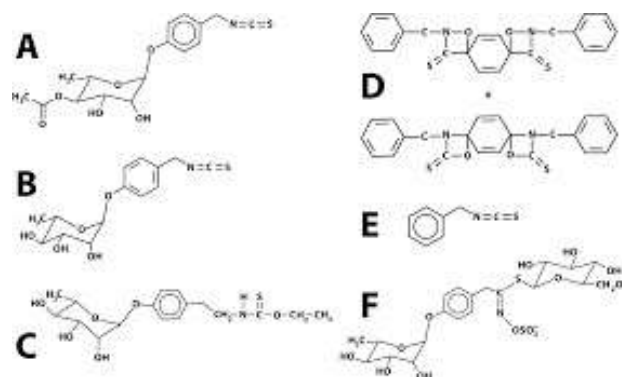
Figure 1 Possible structures of Moringa Oleifera. Mexican Journal of Biodiversity 82: 1071-1082, 2011

Figure 2 shows the possible chemical structure of lignin, an insoluble material in the orange peel.
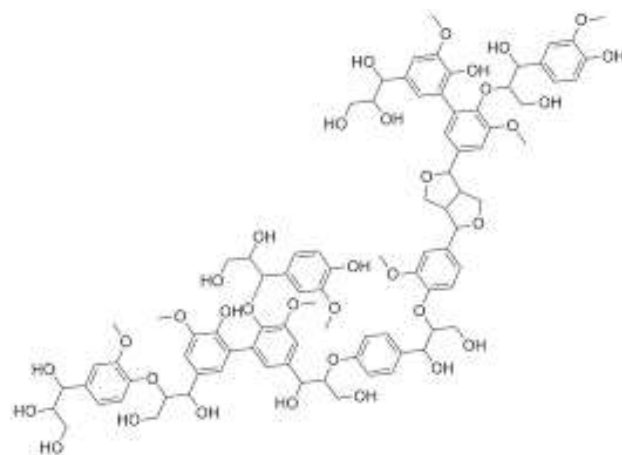
Figure 2 Possible structure of Lignin
Yair Santiago Saenz

Moringa oleifera seeds have been shown to contain significant amounts of polar amino acids, with a net positive and negative charge, which could interact with the colloidal particles responsible for turbidity and color during the water clarification process, contributing to their elimination. , [2] Moringa oleifera is a crop native to northern India, currently abundant throughout the tropics. The variety of names in both English and vernacular illustrates the many uses assigned to the tree and its products.

In the case of the vermicompost process, the aim is to evaluate the contribution of nitrogen (N) and other nutrients in the compost tea to produce beans in a hydroponic NFT process, using the compost tea as a hydroponic solution.

Methodology

The orange peels were obtained from the Mexican Citrus Company, located in the Municipality of Montemorelos, Nuevo León, as well as from the Don Luis juicer, located in the Central de Abasto, Guadalupe municipality, Nuevo León. We worked with orange peels of the Mars variety, from which the bagasse was removed and only the flavedo and albedo of the orange were worked. It was subjected to a bleaching process and the essential oil was subsequently extracted and thermochemically transformed into charcoal and subsequently a pyrolysis process was carried out at 370 ° C. These materials were characterized in a Fourier Transform Infrared Spectroscopy, FTIR equipment. The Fourier Transform Infrared Spectroscopy analysis was carried out on a Nicolet iS10 Thermo Scientific brand with universal ATR iTR sampling accessory, the analysis was carried out at 32 scans, the sample was previously dried at a temperature of 70 ° C for a time of 24 hours.

Moringa Oleifera seeds have a high content of vegetable oil in their composition, which must be extracted in order to take advantage of the protein that the seeds contain, which is important during the water coagulation process. For the extraction of the oil from the Moringa Oleifera seeds, it was necessary in the first stage to submit them to a manual dehulling process, thus eliminating this element which is not necessary during the coagulant preparation process;

Once the seeds were dehulled, they were introduced and crushed inside a porcelain capsule with the help of a mortar, thus reducing their size and making them easier to handle during the oil extraction process. For the oil extraction process from Moringa Oleifera seeds, a solvent extractor equipment was used. In Figure 3 a part of the proposed methodology for the pre-treatment and the obtaining process is observed. The Fourier Transform Infrared Spectroscopy analysis was carried out on a Nicolet iS10 Thermo Scientific brand with universal ATR iTR sampling accessory, the analysis was carried out at 32 scans, the sample was previously dried at a temperature of 85 ° C for a time of 24 hours.
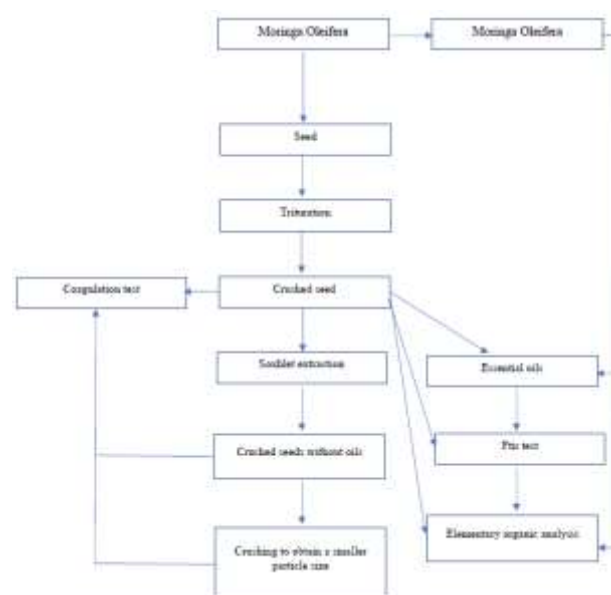
Figure 3 Methodology used for the processing of moringa fiber as a possible coagulant of impurities in water

In the study of vermicompost, organic household waste was collected in order to subject it to a biological process through degradation using the Californian red worm, (Eisenia foetida), the vermicompost was monitored under the following variables: degree of darkness in the substrate, pH level, and moisture percentage, as well as its Nitrogen content as a possible nutritive agent. The data obtained by FT-IR and the N content indicate that this leachate is highly nutritious and can replace an inorganic nutrient solution. The corresponding chemical analyzes were carried out, in order to qualitatively detect the Nitrogen, phosphorus, potassium and pH values using a soil analysis kit, model HI3896 brand Hanna Instruments, the leachate obtained was characterized physicochemically by means of an Infrared Spectroscopy equipment.

By Fourier Transform, ThermoScientific Nicolet iS10 brand FTIR with diamond tip ATR accessory. The degree of humidity was detected by the method proposed by Ferruzi (1986), which consists of compressing a handful of the substrate material with the hand and checking that, being completely wet, it does not release water.

Results

In the infrared spectrum of Figure 4, it is observed how the -OH groups are present in the 3320 cm^{-1} band, these functional groups are characteristic of the cellulose present in the plant material, as well as of the molecular moisture present in the sample, in the same way the methyl groups -CH$_3$ and methylenes -CH$_2$ that correspond to the groups located in the band 2923 cm^{-1} characteristic of the carbon chain of the polysaccharides present, as well as the many components of the shell, such as limonene, which is a terpene. In the 1607 cm^{-1} absorption band, the characteristic band of the carbonyl group is observed, typical of the carboxylic acid groups, specifically, of the citric acid contained in the composition of the orange peel, which is a tricarboxylic acid - COOH , located on the 1729 cm^{-1} band.
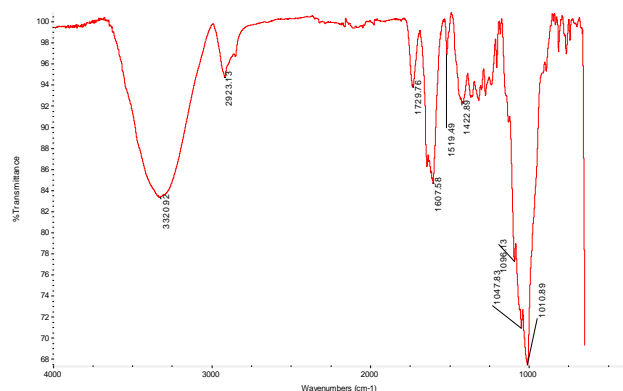
Figure 4 Fourier transform infrared spectrum of the orange peel sample

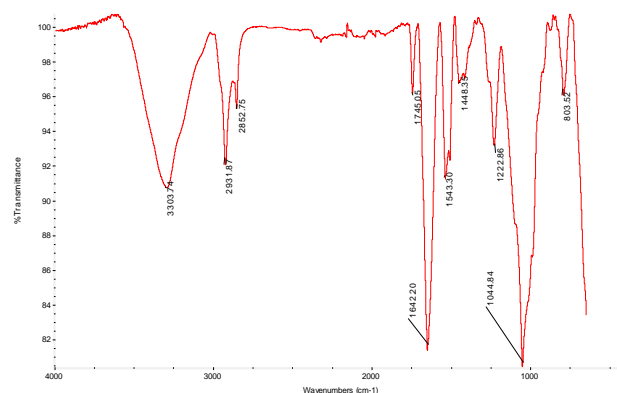Figure 5 shows the Fourier transform infrared spectrum of the Moringa sample [5] processed, according to the methodology cited in Figure 3. The active functional groups present in the moringa powder were determined using the technique by FT-IR.

The results obtained by means of the FT-IR technique indicate similar profiles with characteristic bands of lignocellulosic materials.

Figure 5 Fourier transform infrared spectrum of the moringa oleifera sample

Based on the assignments presented in the literature, bands located around 3303cm-1 are observed, which can be attributed to the stretching vibrations of O-H groups present in proteins, fatty acids, carbohydrates (cellulose and hemicellulose) and lignin. A contribution in this region can also be inferred from N-H and C-H groups that also absorb in this infrared region and that are overlapping with the O-H group.

The peaks at 2931 cm-1 and 2852 cm-1 assigned to the symmetric and asymmetric stretching of C-H groups corresponding to the CH$_2$ groups present in fatty acids. An intense band is observed at 1642 cm^{-1} characteristic of the vibrations of the carbonyl group (C = O). A small band observed at 1735 cm^{-1} suggests that the carbonyl group may be present in different structures. In this case, the band at 1745 cm^{-1} can be associated with fatty acids and the band at 1642 cm^{-1} with the amide group in proteins. A small interaction is also observed around 1543 cm-1 which can be assigned to stretching of C-N bonds and / or N-H deformation. Likewise, an intense band around 1448 cm^{-1} stands out, attributed to the N-H bonds present in the amides.

The presence of these bands confirms the presence of protein in the moringa seeds studied. This protein is responsible for the coagulation of the suspended particles present in the water. Regarding the vermicomposting process, the following results were obtained:

Next, the results obtained from the chemical characterization of the californian red worm leachate are shown, in Table 1 some of the qualitatively obtained values of the earthworm leachate can be observed.

No.	Analysis Type	Results
1	Worm reservoir moisture	70-80%
2	Nitrogen content in solid humus	High level
3	Potassium content in solid humus	Medium level
4	Phosphorus content in solid humus	Low level
5	Hydrogen potential in leachate	8.0
6	C / N ratio in leachate	8.0 a 11.0
7	Average temperature of the worm reservoir	20 °C
8	Nitrite NO2 content in leachate	5.0 mg/L
9	Nitrate NO3 content in leachate	160 mg/L

Table 1 Quantitative and qualitative results of earthworm leachate and vermicompost

Next, the infrared spectrum performed on the worm leachate sample is described, which presented a dark coloration, without odor, without residues because it was previously filtered and oxygenated. Figure 6 shows the bands corresponding to the OH groups in 3345 cm-1 well defined and corresponding to the bands that overlap the OH bands of the functional groups such as .C-H-stretching and combinations of the nutrients. The leachate sample contains to a large extent fulvic and humic acid, its main functional groups are: OH, $C = O$, which is observed in the 1625 cm^{-1} band
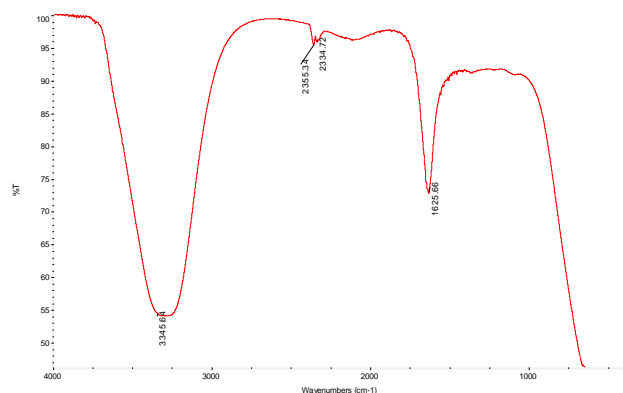
Figure 6 Fourier transform infrared spectrum of the leachate or compost tea sample

Conclusions

The presence of organic waste in landfills has very negative effects on the environment, such as emissions of methane, which is a powerful greenhouse gas, contamination of aquifers by leaching and odors in nearby inhabited areas.

The transformation of organic waste, by the most convenient method is important, since this notably reduces pollution by solid waste in the open.

The residual agro-industrial biomass (orange peels) as well as the forest biomass (moringa leaves), and products obtained from biological processes can be used for material or energy uses, seeking an adequate balance between them. In addition to producing paper or wood, biomass can be used to replace non-renewable materials. This can help decarbonize the economy, reducing dependence on fossil fuels, improving security of supply and avoiding climate change.

Green chemistry is emerging as an emerging sector that is reaching a growing share in the most dynamic economies.

The liquid extract of earthworm humus is a biostimulant that has been making its way into the national agricultural market for more than a decade. It has been proven that it is an efficient product in the delivery of organic matter to the soil and nutrients to the plants through the irrigation system, with benefits such as the adequate distribution of nutrients in the field and the stimulation of root and aerial development of crops.

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Salivary Flow and ph in pregnant patients

Flujo y ph salival en pacientes en pacientes gestantes

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Abstract

Saliva is multifunctional: cleaning of the oral cavity, lubrication, preservation, repair of mucous membranes and dental hard tissues; the pH and its buffering, also participates in the elimination of bacteria, digestion and speech. The salivary composition in gestational period is altered, with variation of salivary pH and buffer capacity. Objective. To determine the levels of pH and salivary flow that prevail in pregnant patients. Methodology. Descriptive, prospective and transversal study. Sampling for convenience: pregnant patients in the 1st, 2nd and 3rd trimesters who attended the UMF. 61 to medical control of their pregnancy. Using a calibrated JENWAY 3510 Ph Meter potentiometer. Saliva samples were collected at least one hour after eating. Contribution. The salivary pH in pregnant women is lower in the first quarter than in later ones. According to Spearman's test analysis, a positive correlation is reported ($r2 = 0.34$), the correlation of ranges between pH and salivary volume is statistically significant even if it is weak. The salivary pH is lower in the first quarter than in the two subsequent ones, the salivary flow does not vary significantly in the first and second quarters, but it increases in the third quarter.

Saliva, Ph, Pregnant women

Resumen

La saliva es multifuncional: limpieza de cavidad bucal, lubricación, conservación, reparación de membranas mucosas y tejidos dentales duros; el pH y su amortiguación, también participa en la eliminación de bacterias, la digestión y el habla. La composición salival en periodo gestacional se ve alterada, con variación del pH salival y la capacidad buffer. Objetivo. Determinar los niveles de pH y flujo salival que prevalecen en las pacientes gestantes. Metodología. Estudio Descriptivo, prospectivo y transversal. Muestreo por conveniencia: pacientes gestantes 1°, 2° y 3er trimestre que acudieron a UMF. 61 a control médico de su embarazo. Empleando un potenciómetro JENWAY 3510 Ph Meter, calibrado. Las muestras de saliva fueron recolectadas al menos una hora después de comer. Contribución. El pH salival en gestantes es menor en el primer trimestre que en los posteriores. De acuerdo con la prueba de análisis de Spearman, se reporta una correlación positiva ($r^2 = 0.34$), es estadísticamente significativa la correlación de rangos entre el pH y el volumen salivales aun cuando es débil. El pH salival es menor en el primer trimestre que en los dos posteriores, el flujo salival no varía significativamente en el primer y segundo trimestres, pero si aumenta en el tercer trimestre.

Saliva, Ph, Gestantes

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Introduction

Saliva is a fluid present in the oral cavity made up of 99% water and a minimal amount of electrolytes, tiny organic molecules such as hormones and glucose, as well as proteins such as immunoglobulins, enzymes and glycoproteins whose quantity and quality they influence the ability of saliva to perform various functions throughout the day. It is a fluid that, in addition to being composed of the secretions of the major and minor salivary glands, contains a mixture of gingival exudate, microorganisms and their products, epithelial cells, nasal exudate and food remains. Hernández Molinar and Cols. 2019.

Pregnancy is a period of significant physiological, metabolic and morphological changes in women, which elapses from the implantation of the zygote in the uterus until the moment of delivery, with the function of nourishing and allowing the development of the fetus and preparing the body for the mother for breastfeeding. Gestation refers to the development of the fetus, many people refer to these two terms synonymously.

Specifically, changes will occur in the oral tissues produced by the modification of the pH level and the amount of salivary flow, these factors when affected produce favorable conditions for the development and the appearance of biofilm, giving rise to conditions that favor the presence of cavities and periodontal disease, affecting oral health. Bouza Vera et al. 2016.

Saliva is composed of water in about 99%, while the remaining 1% is made up of inorganic compounds, proteins, carbohydrates, lipids, desquamated epithelial cells, bacteria and their products, viruses and fungi, food remains, some bronchial secretions and components of crevicular fluid such as blood cells and immunoglobulins. It is sterile in its place of origin, but when it comes into contact with the crevicular fluid, other foods, microorganisms and desquamated cells of the oral mucosa, it stops being sterile. Edgar WM. 2016.

Objective

Determine the pH and salivary flow levels that prevail in pregnant patients.

Methodology

Descriptive, prospective and cross-sectional study. Convenience sampling: 1st, 2nd and 3rd trimester pregnant patients who attended the UMF. 61 to medical control of your pregnancy. Saliva samples were collected at least one hour after eating.

The sample was made up of 40 pregnant patients from different trimesters of pregnancy, who attended the 61 Family Medical Unit. The total volume of saliva was calculated without taking into account the foam, with an adjustable 1 ml pipet, using plastic tips. The salivary flow rate was calculated taking into account the total collection time and the volume of saliva.

A JENWAY 3510 Ph Meter potentiometer was used, which was previously calibrated by using two buffer substances, one with pH 5 and the other with pH 9. Once calibrated, each sample was measured using the electrode. By recording the results obtained in the registration table of pregnant patients who attended UMF No. 61 and who met the selection criteria, the pH value found was placed in the patient's collection form.

Results

Salivary pH in pregnant women is lower in the first trimester than in the later ones. According to the Spearman analysis test, a positive correlation is reported ($r2 = 0.34$), the correlation of ranges between pH and salivary volume is statistically significant even when it is weak. Salivary pH is lower in the first trimester than in the subsequent two, salivary flow does not vary significantly in the first and second trimesters, but does increase in the third trimester.

Gestational Trimester				
Gestational Trimester	1st Trimester	2nd Trimester	3rd Third	Total
Px Pregnant	5	15	20	40
	12.50%	37.50%	50%	100%
n-%	5- 12%	15 - 37.5 %	20 - 50%	40 - 100%

Table 1 Pregnant patient population by gestational trimester

Population of Pregnant Patients by age.
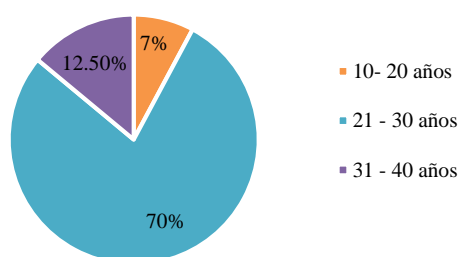
Graphic 1 Percentage population of pregnant patients by age

Graphic 2 Socioeconomic level of the pregnant women in the study

Of the total sample of 40 patients, who completed the socioeconomic questionnaire, we found that the socioeconomic level that most predominates in C-, followed by D +, the socioeconomic level that least predominates is D.

The classification in Mexico is:

− Socioeconomic Level A / B is High
− Socioeconomic Level C + is Medium High
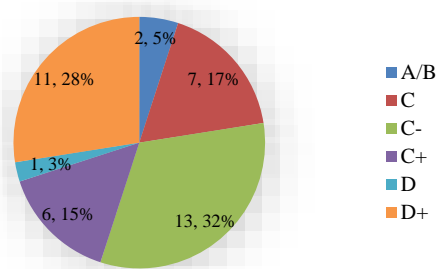− Socioeconomic Level C is Typical Medium
− Socioeconomic Level C- is Medium Emerging
− Socioeconomic Level D + is Low Typical
− Socioeconomic Level D is Extreme Low
− Socioeconomic Level E is Low Very Extreme

Central trend measures in relation to the study variables			
Pregnant	Trimester	Salivary volumen	PH
Half	2.37	6.39	7.6
Fashion	3	6	7.3
Median	2	6	7.6

Table 2 Central trend

Spearman analysis

Independent variables	Standard deviation	Coefficient	P
Salivary pH	0.34	0.34	0.033
Salivary volume	3.77		*

Table 3 A p of 0.05 was established as statistically significant

According to the Spearman analysis test, a positive correlation is reported (r2 = 0.34), the correlation of ranges between pH and salivary volume is statistically significant even when it is weak.

Discussion

It has been shown that there are variations in the chemical composition of saliva and that this varies not only from subject to subject, but within the same subject. Numerous factors are those that influence both the quality of salivary flow and its composition, among which are: eating, circadian rhythm, sex, age, climate, height, as well as ingestion of drugs, drugs, genetic factors and physiological states.

In the present study of 40 pregnant patients, it was found that the salivary pH of pregnant women is lower in the first trimester than in the subsequent two, due to continuous nausea, vomiting, absence of toothbrushing, hormonal factors, as well as the time The collection of saliva and the stimulus used play a preponderant role in saliva pH.

In the present study we were able to observe that salivary flow does not vary significantly in the first and second trimesters of pregnancy, but it does increase in the third trimester, according to the work of Hernández Molinar, 2019, giving as a possible explanation the hormonal factor, which plays an important role in saliva secretion.

Conclusions

− The research hypothesis is affirmed, concluding: There is a relationship between the pH level and the amount of salivary flow in pregnant patients.
− The patients of the population that predominated the most during the study carried out were those in the third trimester.

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– According to the information collected from 40 patients, the average salivary pH was 7.6.

– According to the information collected from 40 patients, the average salivary volume was 6.3 ml.

– Finally, it is concluded according to Sperman's statistical study that there is a positive and significant correlation between the two study variables of p = 0.033

Acknowledgments

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Article

Ultrafine particle dispersion in the metropolitan area of Guadalajara, Mexico

Dispersión de partículas ultrafinas en el área metropolitana de Guadalajara, México

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Abstract

Objectives: Dust, soil and leaf samples of *Ficus benjamina* were collected in the metropolitan area of Guadalajara (GMA) (Peña-García *et al.,* 2017), allowing to identify the type of metallic particles, size, shape and spatial distribution. With the results obtained, the possible effects of metallic particles on human and plant health were discussed (Peña-García *et al.,* 2019). Methodology: The sampling was in six municipalities of the GMA; Atomic absorption spectrophotometry analyses were carried out on leaves, which identified the presence of various elements that mostly exceeded the reference values. Through X-ray fluorescence, 23 elements were identified in soil, including Th and Ac in at least 14 sites. Using the scanning electron microscopy technique and elemental mapping analysis, coarse, fine and ultrafine metallic particles were identified in human bronchus and lung tissue, as well as fragments of cement, plastic, yeast and bacteria. The similarity between the metallic particles in the collected samples and those observed in lung tissue, warns of latent risks to the health of the GMA population. Contribution: The results obtained with the methodology used in this work allow us to glimpse the polluting potential in urban areas.

Urban dust, *Ficus benjamina*, Heavy metals

Resumen

Objectives: Se recolectaron muestras de polvo, suelo y hojas de *Ficus benjamina* en el área metropolitana de Guadalajara (AMG) (Peña-García *et al.,* 2017), permitiendo identificar el tipo de partículas metálicas, tamaño, forma y distribución espacial. Con los resultados obtenidos se discutió sobre los posibles efectos de partículas metálicas en la salud humana (Peña-García *et al.,* 2019). Methodology: El muestreo fue en seis municipios del AMG; se realizaron análisis de Espectrofotometría de absorción atómica en hojas con lo que se identificó la presencia de diversos elementos que en su mayoría superó los valores de referencia. Mediante fluorescencia de rayos X se identificaron 23 elementos en suelo, entre ellos Th y Ac en al menos 14 sitios. Con la técnica de microscopía electrónica de barrido y análisis por mapeo elemental, se identificaron partículas metálicas gruesas, finas y ultrafinas en bronquio y tejido pulmonar humano, así como fragmentos de cemento, plástico, levadura y bacterias. La similitud entre las partículas metálicas en las muestras recolectadas y las observadas en tejido pulmonar, advierte riesgos latentes en la salud de la población del AMG. Contribution: Los resultados obtenidos con la metodología empleada en este trabajo permiten vislumbrar el potencial contaminante en las zonas urbanas.

Polvo urbano, *Ficus benjamina*, Metales pesados

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† Researcher contributing as first author.

Introduction

In Latin America and Mexico, productive activities have impacted the quality of life of the population and the environment, as well as the heavy vehicular load and the low rainfall (Querol, 2008). One of the biotic elements that have been used to characterize atmospheric pollution in urban dust, soil, suspended particles, sediments and in some plant species (Tam *et al.*, 1988; Aguilar *et al.*, 2011). It is particularly interesting to note that vegetation can be used as a biological indicator of trace elements, coarse, fine and ultra-fine particles from polluted air.

These bio-indicators have a high sensitivity to environmental changes in living beings, allowing to evaluate air quality in a very viable, fast and economical way and, most importantly, they can distinguish accumulations of toxic and polluting substances in ecosystems. Magnetic susceptibility techniques (Aguilar *et al.*, 2012), infrared (Sangi, *et al.*, 2008), scanning electron microscopy (Tomašević *et.al.*, 2005), X-ray fluorescence (Marguí *et.al.*, 2009) and atomic absorption (Sawidis *et.al.*, 1995), have been used to identify and quantify a wide variety of airborne particles deposited on plant leaves.

The present work was carried out in six municipalities of the metropolitan area of Guadalajara (MAG), the samples were collected on March 23, 2013, in which the atmospheric contamination produced by metallic particles deposited on the ground and leaves of *Ficus benjamina* from the Metropolitan Area of Guadalajara, Mexico (Peña-García *et al.*, 2016). In addition, the possible adverse effects on human health and on vegetation as a consequence of the presence of these particles are presented.

The following variables were defined: a) the chemical composition of the particulate material deposited on *Ficus benjamina* leaves, b) the presence of heavy metals in the soil, c) the amount of dust deposited on sidewalks, c) particles in the lung tissue of cadaveric samples observed (Instituto Jalisciense de Ciencias Forenses) (Peña-García *et al.*, 2019a).

The PM deposited in the soil and in the *Ficus benjamina* leaves from the air pollution in the AMG, are constituted by a wide variety of heavy metals of different morphologies and sizes that can affect human health and the photosynthetic process of this species of tree (Peña-García *et al.*, 2016).

Methodology

For the analysis of the *Ficus benjamina* leaf samples, more than one technique was used in order to corroborate the presence of the identified elements. We start with SEM images and their respective elemental mapping analysis (Peña-García *et al.*, 2016), by X-ray energy dispersive spectrometry (EDS) to know the morphological and chemical characteristics of the localized particles. Later atomic absorption spectroscopy to determine concentration of elements such as Cu, Cd, Co, Cr, Ni, Pb and Zn (Peña-García *et al.*, 2019c). The magnetic properties were also analysed, with which a spatial distribution map of the magnetic susceptibility of heavy metals was elaborated to determine the areas with the highest presence of pollutants (Peña *et al.*, 2016; Peña García *et al.*, 2019c).

For soil, the selected technique was XRF through a qualitative elemental chemical analysis of elements comprised between fluorine (F) and uranium (U) (Peña-García *et al.*, 2019c).

With the urban dust samples, the geostatistical interpretation was made and the map with the representation of areas of the city with higher dust density on the sidewalks (Peña-García *et al.*, 2016).

Results

Through SEM, it was possible to determine the sedimentation of dust on both sides of the *Ficus benjamina* leaves that were systematically observed in several of the samples, so it can be deduced that a significant amount of particulate matter (PM) is present floating in the atmosphere of the GMA and are preserved in the leaves of the trees (Peña-García *et al.*, 2019c). Of the samples observed in one, 26 elements were present, three with 21, three with 19, one with 17, one with 16 and two with 14 elements present, with different land uses and types of roads (Peña-García *et al.*, 2018).

Traces of heavy metals such as Cd, Co, Cu, Pb and Zn were also observed in samples from other sites analysed by atomic absorption spectroscopy. Few fine and ultra-fine particles with oval and spherical shape were observed in all cases, as well as large aggregates (Peña-García *et al.,* 2019b). Also, aggregates of metal particles of irregular shape and size <1 µm which predominated in the leaves collected in other urban areas of Mexico (Reyes *et al.,* 2012) and a great variety of heavy metals of micrometric size have been reported in other countries (Tam *et al.,* 1988).

The most abundant elements were Cu, Pb and Zn, (14.58-24.72 mg/Kg) and in lower concentrations Cd, Cr, Co and Ni (3.46-5.93 mg/Kg) (Peña-García *et al.,* 2019c). The average concentration of all heavy metals (except Zn) was higher than the value reported in the "reference plant" proposed by Market (1992). The concentration values for Cd, Co, Pb Ni, Cr and Cu were 69, 26, 20, 3.9, 3.6 and 2.47 times higher than the reference values, respectively. The high concentrations can be attributed to the progressive accumulation of metals in the leaves over time (Peña García *et al.,* 2019c).

Regarding the magnetic parameters, the samples were divided into categories, such as land use and type of road. The highest average values of mass magnetic susceptibility are given for industrial land use (7.56 μm^3 kg^{-1}), mixed (6.29 μm^3 kg^{-1}), and urban corridor (6.46 μm^3 kg^{-1}), as well as in roads of zones agricultural (7.20 µm3 kg-1) primary (6.04 µm3 kg-1) and secondary (6.07 µm3 kg-1) routes. A significant difference was identified in the average values of the different categories for land use and roads for χd% and MRIS. Regarding MRI0.7 T and χ both present an almost linear trend, which indicates the presence of carriers of the ferrimagnetic type, clustering patterns of sites are observed according to land use and type of road.

The values of low magnetic concentration belong to a group of samples that are associated with: a) categories of land use of green areas, one of them in the Sierra la Primavera, the other in the Parque de la Liberación, b) undeveloped intraurban and c) the agricultural and control zone.

The highest values of magnetic concentration are observed in land use a) industrial, mixed, urban corridor and b) with primary or secondary roads. The polygon that presented the highest concentration of magnetic particles was the one corresponding to the International Airport "Miguel Hidalgo y Costilla" and its surroundings, as well as the polygon where the Military Air Base is located and extensive areas of entry or exit of the city, as well as Av. Lázaro Cárdenas which crosses the city from Southeast to Northwest, and in a good part of the city is accompanied by the railroad, on which a great variety of substances and materials such as food, machinery, agrochemicals, products are transported. automotive, cement, industrial products, mineral coal, coke, asphalt, paraffin, diesel, fuel oil, iron ore, copper concentrates, silica sand, clays, fluorite and chemical products, among many others (Peña *et al.,* 2016; Peña-García *et al.,* 2019c).

Of the 12 samples (12 individuals) of lung tissue observed in the IJCF, 19 elements were identified in two individuals, 10 in two, three presented nine elements, two more had eight elements and in three more individuals between seven and five elements were observed. The most abundant elements were Al, Pb, As, Hg and W. The least abundant were Zn, Ta, Nb, Hf, Cu and Rh (Peña-García *et al.,* 2019a; Peña García *et al.,* 2019c).

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Conclusions

The diversity of techniques used for the analysis of the samples allowed us to first observe, then identify and finally corroborate the presence of metallic elements in the samples. The SEM technique gave us the facility to observe the shape, size and composition of the particles. By means of XRF, the presence of 21 elements was determined, one non-metal Br and two radioactive elements Ac and Th.

The areas with the highest amount of dust were the Guadalajara International Airport "Miguel Hidalgo y Costilla", the junction between the highway to Chapala and the Manuel Gómez Morín peripheral ring in the municipality of Tlaquepaque, as well as the extension of Av. López Mateos in the municipality of Tlajomulco de Zúñiga, and the area of the XV military zone, north of the city. It is important to note that in the surroundings of the GMA there are a large number of brick kilns, 831 which burn any kind of waste to supply the kilns.

Atomic absorption spectroscopy allowed the identification of concentrations of the most abundant, Cu and Pb. In Cd, Pb and Zn are very evenly distributed on Lázaro Cárdenas avenue until reaching the Mercado de Abastos area. The concentration values of Cd, Co, Cr, Cu, Ni and Pb deposited on leaves, exceeded the reference values.

The high concentration of heavy metals found shows that the quality of the ambient air in the GMA is unhealthy, so it would be expected that there would be a correlation between this aspect and the health of the population that resides here. It is important to highlight that the diameter of the particles present in the *Ficus benjamina* leaves are fundamentally less than 2.5 microns ($PM_{2.5}$) and aggregate states, and that the health problems of the GMA population are associated with fine PM.

In the lung, 21 elements were identified, in addition to observing the shape and size of the particles. Said images were compared with some other environmental particles presented by various authors. Some of the uses of these elements are used in the automotive, electrical and medical industries, in addition to the food industry where they also have great influence. The dust samples collected in this way represent the air that exists at the level that is breathable by the population.

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Spectroscopic and thermogravimetric studies of homogeneous materials from PU/PMMA/SiO₂

Estudios espectroscópicos y termogravimétricos de materiales homogéneos a partir de PU/PMMA/SiO₂

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Abstract

Polymers of organic-inorganic origin are incompatible by nature and a proposal to solve this behavior is the formation of Interpenetrated Polymeric Networks (IPN) using coupling agents. Coupling agents make it possible to create a crosslinking between the phases present that provides better mechanical, optical and thermal properties. These materials are known as Hybrid Networks. To obtain optically transparent materials, individual networks of Polyurethane (PU), Methyl Polyacrylate (PMMA) and Silica (SiO₂) were used. Binary and ternary networks were synthesized using bulk polymerization incorporating SiO₂ up to 10% by weight. In this research, coupling agents such as Trimethoxysilyl Propyl Methacrylate (MSMA) and Isocyanotopropyl Triethoxy Silane (IPTS) were introduced to the ternary networks in order to reduce the phase separation that occurs in these systems. Fourier Transform Infrared Spectroscopy (FTIR) studies demonstrated the presence of functional groups of binary and ternary networks. On the other hand, the thermogravimetric tests (TGA) carried out on hybrid IPN´s with coupling agents, presented greater thermal stability and better optical properties, providing the new IPN´s with the opportunity to have promising applications.

Resumen

Los polímeros de origen orgánico-inorgánico son incompatibles por naturaleza y una propuesta para solucionar este comportamiento es la formación de Redes Poliméricas Interpenetradas (RPI) utilizando agentes acoplantes. Los agentes acoplantes permiten crear entre las fases presentes un entrecruzamiento que proporciona mejores propiedades mecánicas, ópticas y térmicas. A estos materiales se les conoce como Redes Híbridas. Para obtener materiales ópticamente transparentes, se trabajaron con redes individuales de Poliuretano (PU), Polimetil metacrilato (PMMA) y Sílica (SiO₂). Se sintetizaron redes binarias y ternarias empleando la polimerización en masa incorporando SiO₂ hasta en un 10% en peso. En esta investigación, se introdujeron agentes acoplantes como el Trimetoxisilil Propil Metacrilato (MSMA) y el Isocianotopropil Trietoxi Silano (IPTS) a las redes ternarias con el propósito de reducir la separación de fases que ocurre en estos sistemas. Los estudios de Espectroscopía Infrarroja por Transformada de Fourier (FTIR), demostraron la presencia de los grupos funcionales de las redes binarias y ternarias. Por otro lado, los ensayos termogravimétricos (TGA) realizados a las RPI´s híbridas con agentes acoplantes, presentaron mayor estabilidad térmica y mejores propiedades ópticas, proporcionando a las nuevas RPI's la oportunidad de tener aplicaciones prometedoras.

Interpenetrated Networks, IPN´s

Redes Interpenetradas, RPI´s

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Introduction

The first polymeric networks were synthesized in the 20th century (Kausar, 2019). Interpenetrated Polymeric Networks are defined as Polymers that comprise two or more networks that are at least partially entangled on a molecular scale without covalent bonds with each other and cannot be separated unless the chemical bonds are broken (Kumar et al. 2018). Commonly, RPI's are prepared from a mixture of two monomers or polymers that are miscible. However, in this work, a network of inorganic origin has been incorporated, using coupling agents to obtain homogeneous materials that have better optical, mechanical and thermal properties; The formation of IPN's is a valuable strategy to reinforce and optimize the properties of a polymer network by combining a second network in it (Liang and Deng, 2017).

The first synthesis of mineral materials from polymerization reactions using molecular precursors of the metal alkoxide type was carried out by Ebelmen in 1845, obtaining with some gems such as sapphire, ruby and emerald (Sanchez et al, 1996). This method of manufacturing materials is known as the "sol-gel procedure", arousing strong interest for renewal both in the university community and in the industry.

The presence of organic composites makes it possible to modify the mechanical properties, produce films and fibers, obtain by simple molding various geometric structures for integrated optics, control porosity and adjust the hydrophilic / hydrophobic balance of the network. For their part, inorganic composites can play various roles, such as: contributing to increase the mechanical and thermal stress of the material, allowing the refractive index to be modulated, as well as adding electrochemical, magnetic and electrical properties (Babonneau et al., 1996). That is why the RPI's that are formed from organic / inorganic composites achieve excellent optical, thermal and mechanical properties.

The networks are classified according to the Interpenetration mode: if both polymeric systems are partially, semi or fully cross-linked.

The analysis of the properties of PU, PMMA and SiO2 is of vital importance, since PU has excellent elasticity, resistance to abrasion and damping properties (Kausar 2019); on the other hand, the crosslinked network of PMMA is an amorphous polymer that has high transparency and high mechanical resistance; finally, the SiO2 network, thus allowing the obtaining of a highly cross-linked inorganic network in an organic matrix without risk of decomposition or degradation.

In work carried out by Ghosh, (et. Al.) 2018 synthesized biodegradable and intelligent RPI's from PU, silicone and polystyrene, which exhibited good mechanical properties, biodegradability, impact resistance, scratch resistance as well as good thermal stability.

For its part, Bonilla, 2005, synthesized ternary hybrid materials, where the silica network obtained was synthesized from TEOS using the sol-gel method incorporating up to 37% by weight of TEOS, which upon polymerization formed a network of SiO2 improving the thermal stability of materials above 700°C.

In this work, interesting results were obtained with respect to hybrid networks. The presence of an inorganic network can be considered as a protection for the organic network, because it raises the thermal decomposition temperature of the polymer. The thermal transition temperatures of the PU / SiO2 and PMMA / SiO2 hybrids are similar to that of the pure polymer. If a crosslinking agent (coupling agents) is added, the phase separation is lower and therefore its thermal stability is greater.

Methodology (Bonilla, 2005)

Section 1. Synthesis

The synthesis of the binary and ternary networks is presented below:

a) PU / PMMA network, the NCO, OH, MMA and TRIM monomers were mixed (with a 50/50 weight ratio) and 0.5% by weight of BPO was added for the formation of the PMMA network; DBTL was added for the formation of the PU network;

b) PU / SiO2 network, in ethyl acetate the monomers NCO, OH and TEOS were dissolved (for 5, 10, 15% by weight of SiO2 in the final sample) and the PU catalyst, finally added the aqueous HCl solution;

c) PMMA / SiO2 network, at the beginning of the reaction the monomer MMA used as solvent for the rest of the components was added. TRIM and TEOS were homogenized (5, 10, 15% by weight calculated). The initiator of the PMMA network was incorporated by magnetic stirring and finally the aqueous HCl solution was added;

d) PU / PMMA / SiO2 network without coupling agents. From previous studies, the highest quantity of TEOS incorporated in binary systems was obtained, with a 45/45/10 ratio by weight, the monomers (NCO, OH, MMA, TRIM and TEOS) were mixed by adding the network initiator of PMMA, the catalyst for the PU and the finally, the aqueous solution in the sol-gel processes of the TEOS were also incorporated;

e) PU / PMMA / SiO2 network with coupling agents, the coupling agents are □-Isocyanate propyl triethoxy silane (IPTS) and 3- (trimethoxy silyl) propyl methacrylate (TSMA) as grafting agents for PU networks and PMMA, respectively, which were added at a maximum 4% by weight, for ternary networks.

Section 2. Characterizations

The RPIs that were formed were characterized by the techniques of: Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA). Fourier transform infrared spectroscopy (FTIR). The FTIR assays were obtained from a Perkin Elmer Spectrum One equipment with a resolution of 2 cm-1 and 32 scans on KBr chip. On the other hand, the thermogravimetric analysis (TGA) was carried out in a TA Instruments Model SDT 2960 Simultaneous DSC-TGA equipment, with 20 mg of sample in an aluminum tray with a temperature ramp from Tamb to 800° C, with a heating rate 5° C / min in nitrogen atmosphere

Results

Section 1

Table 1 shows the results of the binary RPIs of PU / SiO2 at different concentrations of TEOS. Table 2 shows the results of the PMMA / SiO2 networks. Table 3 shows the results of the RPI's of PU / PMMA / SiO2 at different concentrations of TEOS with and without coupling agents.

% in weigh		Appearance of the sample
PU	TEOS	
95	5	Translucent, flexible
90	10	Translucent, soft-rubbery
85	15	Translucent, rubbery
80	20	Appearance of the sample

Table 1 RPI's of PU / SiO2 at different concentrations of TEOS
Own Source

% in weigh		Appearance of the sample
PMMA	TEOS	
95	5	Translucent, rigid
90	10	Translucent, rigid
85	15	Opaque, semi-rigid
80	20	Opaque-White, fragile

Table 2 RPI's of PMMA / SiO2 at different concentrations of TEOS
Own Source

% in weigh					
PU	PMMA	TEOS	IPTS	TSMA	Ap
45	45	10	-	-	* Tr/Sr
41	41	10	4	4	* Tr/Sr

Table 3 RPI's of PU / PMMA / SiO2 at different concentrations of TEOS and coupling agents (IPTS, TSMA), Ap. Aspect, * Translucent, semi-rigid (Tr / Sr)
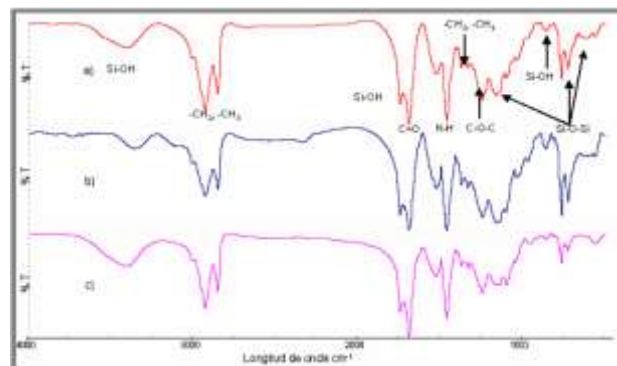*Own Source*

Section 2
Infrared spectroscopy (FTIR)

The results obtained from the FTIR tests are described below: i) Figure 1 FTIR spectrum for PU / SiO2 binary RPIs: a) 95/5, b) 90/10 and c) 85/15% in weight; ii) Figure 2 FTIR spectrum for the PMMA / SiO2 network: a) 95/5, b) 90/10 and c) 85/15% by weight; iii) figure 3 FTIR spectrum for the PU / PMMA / SiO2 system in a range of 4000–500 cm-1 and ternary with and without coupling agents ternary with and without coupling agents. In Figure 1, the infrared spectrum of the PU system network with 5, 10 and 15% by weight of SiO2 is observed.

The presence of representative groups of PU and SiO2 in the three spectra is remarkable. The three compositions of TEOS to form the silica network indicate that the inorganic network was formed in the polyurethane network; the representative bands of the inorganic network (SiO2) at 1103-1079, 789-751 and 585-507 cm-1. The band of the urethane group at 1468 cm-1 corresponds to the N-H bending. The carbonyl group attached to the monosubstituted amine (-CO-NH-) at 1526 cm-1. The bending and stretching of the carbonyl group (C = O) is at 1742 cm-1.

The peaks representing the C-H asymmetric stretching are observed in the range of 2987-2822 cm-1, corroborating their appearance at 1320-1362 cm-1. In figure 2, the characteristic bands of the PMMA network show the stretching of the methyl groups (-CH3) at 2994 and methylenes (-CH2) at 2942 cm-1, corroborating their appearance at 1470 cm-1 and 1738 cm-1 the carbonyl group band (C = O) is observed, assigned to the ester group of the PMMA chain. The characteristic peaks for the Si-O-Si bonds are at 1214-1120, 852-748 cm-1 and 516-490 cm-1; OH groups are found in the 3300-3700 cm-1 and 950-1008 cm-1 region.

Apparently, the three spectra of the samples do not show great changes, however, in figure 2 c) a shoulder is detected at 1640-1547 cm-1 that is not observed in figures 2 a) and b) and is attributed to silanol groups in the medium, produced by the nature of the polyol and by the higher concentration of TEOS that favors the formation of these.

It should be mentioned that these materials improved their appearance by introducing coupling agents. For the synthesis of these networks, the same conditions of the binary networks were taken obtaining the ternary system resulting in semi-rigid IPN's, with a better formation of the inorganic network, which was observed in the TGA analyzes in section 2 showing a residual weight of 10% in silica, this is attributed to the fact that the inorganic network and the coupling agents provide greater crosslinking to the system and consequently greater thermal stability.


Figure 1 FTIR spectrum for the PU / SiO2 network: a) 95/5, b) 90/10 and c) 85/15% by weight
Own Source
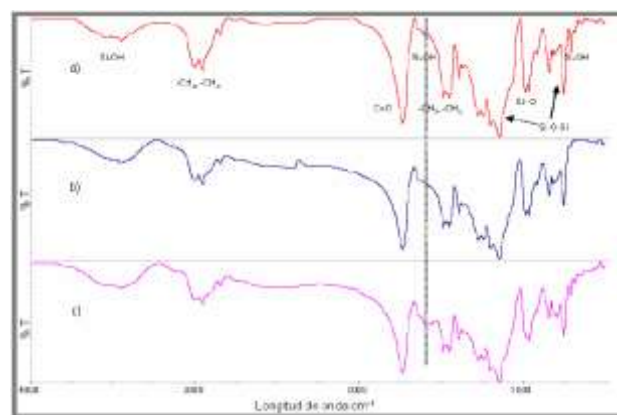
Figure 2 FTIR spectrum for PMMA / SiO2 network: a) 95/5, b) 90/10 and c) 85/15% by weight

Finally, Figure 3 shows the infrared spectrum of the ternary network incorporating into the organic system an amount of TEOS of 10% of the total weight calculated for the network and 4% by weight of the coupling agents. The spectra shown represent the characteristic functional groups of the ternary network without agents and with coupling agents. In the region of 3200-3670 and 940-1002 cm-1, of both spectra, are the bands attributed to the -OH groups, these originate from the OH's of the polyol and residual silanol.
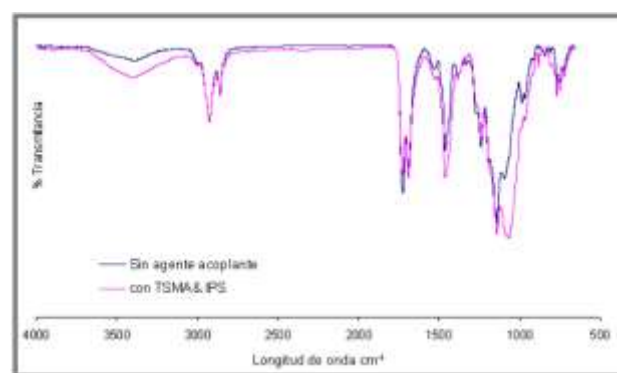
Figure 8 FTIR spectrum for PU / PMMA / SiO2 system in TSMA and IPS

Thermogravimetric Analysis (TGA)

In thermogravimetry (TGA), for a cross-linked polymer, an increase in temperature causes the molecular motion to increase until the polymer molecules degrade. This process occurs in stages, when a substance is heated to different temperatures undergoes a series of transformations, which are attributed to changes in the mass of said substance.

The characterized samples correspond to the binary and ternary hybrid systems with and without coupling agents. Figure 4 represents the TGA of the PU / SiO2 network with 95/5, 90/10, 85/15. Observing the characteristic behavior for the organic network considering that when reaching 500ºC all the organic part has degraded and after this temperature the residual weight corresponds to a silica network.
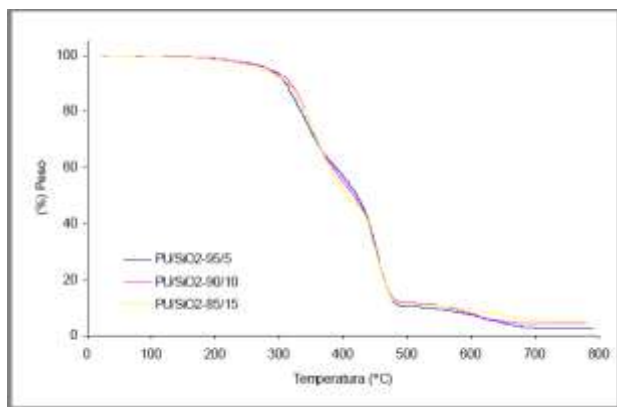
Figure 4 PU / SiO2 binary network thermogram

Figure 5 shows the TGA thermogram of the PMM / SiO2 binary network, where the thermal stability of the sample is close to 800 ºC. It can be seen that the curve that represents the IPN of PMMA / SiO2 whose ratio is 90/10 presents a greater resistance to thermal decomposition, since all the organic part at a temperature close to 400 ºC has decomposed; additionally, the optical properties of the sample were better compared to the samples whose PMMA / SiO2 ratio is 95/5 and 85/15. With the above we can consider that above 500 ºC is only the silica network.
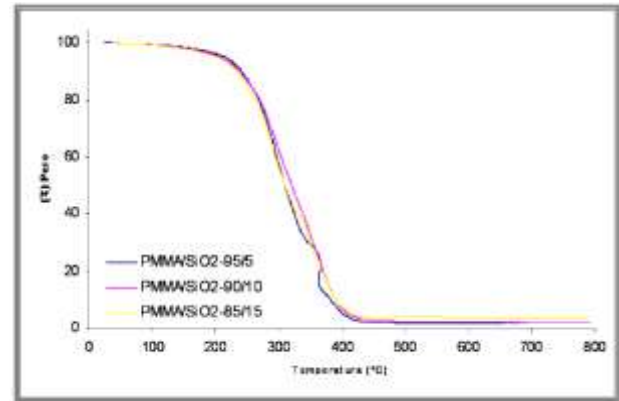

Figure 5 Thermogram of a PMMA / SiO2 network

Figure 6 corresponds to a PU / PMMA / SiO2 thermogram, in this it is possible to appreciate the ternary network whose final concentration corresponds to 45/45/10 and 41/41 / 10-4% with IPTS and MSMA. It is observed that the loss in weight up to 200 ºC is very small, this is attributed to the fact that the humidity in the material is very little, but from 245-378 ºC there is a significant loss in weight; In this first stage, the soft segments of PU, CO2 pyrolysis and PMMA can be decomposed in the two curves with and without agents. In a second stage, the ternary IPN that does not contain coupling agents presents a shoulder in a range of 378-464 ºC that can be caused by the thermal decomposition of secondary organic products such as polyurea that it was possible to observe in the infrared spectra, the segments rigid PU, hydroxyl groups and complete decomposition of PMMA.
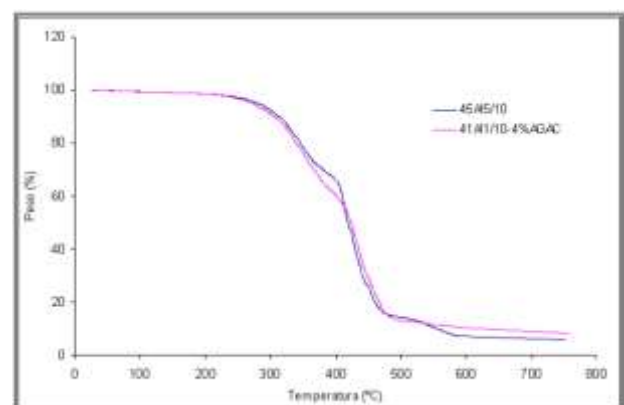

Figure 6 TGA of PU / PMMA / SiO2 ternary networks

Acknowledgments

Conclusions

In the FTIR studies, the representative groups of each system were observed, where the appearance of various bands attributed to silanol (Si-OH) indicate that a partial conversion of silica was obtained. The IPN synthesized without coupling agents presented its thermal stability very close to 800 ℃ with a residual weight of 7%, which is attributed solely to the SiO_2 network since it is considered that all the organic part decomposed around 500 ℃ .

However, the use of coupling agents increased said stability, manifesting a higher residual weight in the SiO_2 content of 10.58%, this is due to the fact that these agents contain within their chemical structure, Si-O groups that increase the active sites for generate the polymerization of the inorganic network in addition to TEOS, causing the network to obtain a higher residual weight of silica.

The tests carried out on the ternary IPNs revealed that by incorporating the three networks in a single system, they affect four important points: 1) formation of secondary products, 2) the thermal stability of the materials, 3) homogeneity of the systems and 4) mechanical properties.

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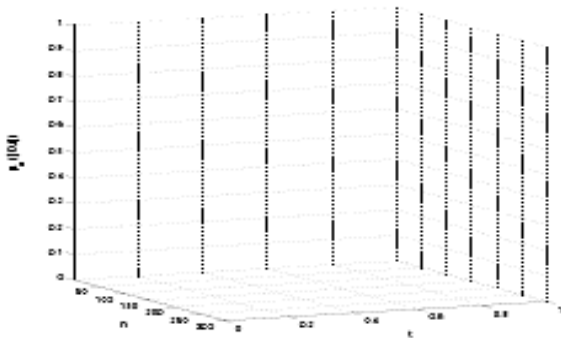
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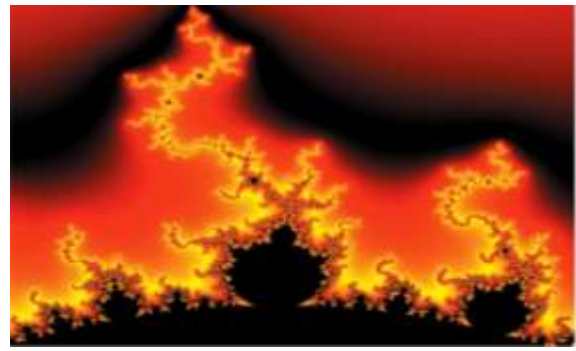
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