



CENTRO DE INVESTIGACION EN MATERIALES AVANZADOS S.C.
MIGUEL DE CERVANTES 120, COMPLEJO INDUSTRIAL CHIHUAHUA
CIM941025MJ1
CHIHUAHUA, CHIH, CP 31136 TEL. 01 614 439 11 00

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"EN CASO DE QUE LA PRESENTE ORDEN DE COMPRA ESTE SUJETA A UN CONTRATO Y EXISTA DISCREPANCIA ENTRE AMBOS DOCUMENTOS, PREVALECERA LO ESTABLECIDO EN EL CONTRATO"

F. REQ. 07/10/2022	PROVEEDOR: 4162-MDPI ST ALBAN-ANLAGE 66, 4052 BASEL, SWITZERLAND, . TEL. 41616837734 FAX. 0	En términos del Artículo 53 de la Ley de adquisiciones, Arrendamientos y Servicios del Sector Público, se aplicará una pena convencional del 1% por cada día de retraso sobre el valor de los bienes no entregados o los servicios no prestados en los términos establecidos en esta orden de compra, la cual se deducirá de su pago. "PARA EFECTOS DEL CÁLCULO DE DÍAS DE ATRASO, SE CONSIDERARÁ A PARTIR DE LA FECHA EN QUE LA ORDEN DE COMPRA SEA COLOCADA"	COTIZACION: CONDICIONES DE ENTREGA: 45 Día (s) CONDICIONES DE PAGO: VS FACTURA TIPO ORDEN DE COMPRA COMPRA DIRECTA NO. DE CONTRATO:
ORDEN DE COMPRA  1A220692			
FECHA ORDEN 14/10/2022			
REQUISICION No.221084	FAVOR DE CITAR EL NUMERO DE ORDEN DE COMPRA EN TODA SU CORRESPONDENCIA, DOCUMENTOS Y EMPAQUES	ALMACEN O ENTREGA BIENES: ALMACEN	

SOLICITANTE: ZARAGOZA CONTRERAS ERASTO ARMANDO

#	PART.	PROYECTO	DESCRIPCION	CANTIDAD	U/A	PRECIO	IMPORTE
1	21502	20520	MATERIAL PARA INF. EN ACT. DE INVEST. CIENTIF . . .PUBLICACIÓN DE ARTÍCULO DEL DR. ERASTO ARMANDO ZARAGOZA CONTRERAS EN LA REVISTA POLYMERS DE LA EDITORIAL MDPI. TÍTULO:"Effect of the addition of different natural waxes on the me- chanical and rheological behavior of PLA" EL COSTO ES EN CHF 1,700.00 FRANCOS SUIZOS (INCLUYE DESCUENTO DE CHF700.00) EL PAGO DEL ARTICULO SE REALIZARÁ UNA VEZ QUE SEA ACEPTADO EL ARTÍCULO POR LA REVISTA POLYMERS DE LA EDITORIAL MDPI Y ENVIARÁ UNA LIGA CON LOS DATOS AL DR. ARMANDO ZARAGOZA. SE ANEXA ESTUDIO DE MERCADO Y JUSTIFICACIÓN. ART. 41 FRACCION I.	1.000	PZA	1,700.0000	1,700.00

ESTA ORDEN ESTA REGULADA POR LA LEY DE ADQUISICIONES, ARRENDAMIENTOS Y SERVICIOS DEL SECTOR PUBLICO

FACTURAR A: CENTRO DE INVESTIGACION EN MATERIALES AVANZADOS S.C. CIM941025MJ1	SubTotal FRANCO, SUIZA	1,700.00
MIGUEL DE CERVANTES 120, COMPLEJO INDUSTRIAL CHIHUAHUA CHIHUAHUA, CHIH, CP 31136 TEL. 01 614 439 11 00	IVA	0.00
TOTAL EN LETRA (* UN MIL SETECIENTOS FRANCO, SUIZA 00/100 FRANCO, SUIZA *)	TOTAL ORDEN	1,700.00

SANCHEZ OLIVAS MARIA AMPARO

DIRECTORA DE ADMON Y FINANZAS

ESCOBEDO LIRA BONIFACIO

JEFE DEL DEPTO. DE ADQUISICIONES

ARAIZA RICO JOEL ARMANDO

SUBDIRECTOR DE FINANZAS

Effect of the addition of different natural waxes on the mechanical and rheological behavior of PLA

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Abstract: In this study, poly(lactic acid) (PLA) blended with different natural waxes (beeswax, cocoa, carnauba, and candelilla) were investigated. Different wax amounts, 3 wt%, 5 wt%, 10 wt%, and 15 wt %, were incorporated into the PLA in a Brabender internal mixer. The blends were characterized by thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), rotational rheometer (RR), and dynamic mechanical analysis (DMA) to observe the effect of different waxes on the PLA physicochemical, rheological, and mechanical behavior. The complex viscosity of the blends was studied by employing a RR. The effect of the addition of the waxes on the mechanical properties of PLA was evaluated by DMA in the tension modality. The results showed that the addition of the waxes tends to slightly decrement the thermal stability of PLA with the addition of any type of wax. However, in the case of the mechanical properties, the cacao wax showed a considerable effect, especially in the elongation at break of PLA.

Keywords: PLA, natural waxes, mechanical properties, rheological, thermal.

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1. Introduction

The increase in demand for disposable items has caused countless ecological problems due to high pollution and their difficulty in being recycled. Therefore, biodegradability is an essential factor to consider in the design of polymeric materials with only one use, for example, packaging for the food industry. Innovation is fundamental for the development of raw materials that exhibit unique characteristics in biodegradation, mechanical and thermal properties, to name a few. For example, polylactic acid (PLA) is a hydrophobic, aliphatic, biodegradable polyester produced by the polymerization of lactic acid molecules [1-3]. However, the final mechanical properties of this polymer are generally deficient. A solution to produce biodegradable materials with suitable mechanical properties is the generation of polymer mixtures. In particular, mixing PLA with naturally sourced plasticizing agents improves polymer flexibility and processing [4]. Therefore, the development of biodegradable polymer mixtures with plasticizers from natural sources is a solution to this problem.

It is reasonable that the plasticizing agent used in the mixture with biopolymers is preferably biodegradable, for example, natural waxes. Waxes are nonpolar lipids; therefore, they are insoluble in water and are highly hydrophobic when dissolved in typical organic solvents [5]. These substances are characterized by being a class of lipophilic components from plants, insects, animal skin, or mineral origin. Beeswax is an example and is the result of a metabolic process of bees. In addition, candelilla wax comes

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