Synthesis and Chraracterizion of Some Lactate Polymers

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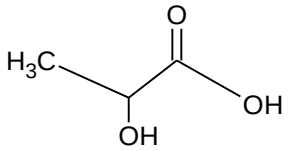
Abstract:

In this work two new biopolymers were synthesized.We could design a new polymer via ring opening of lactide with Arganine to obtain ester-amide polymer(A1), and grafted lactate through back bone of poly acrylic cid(A2). The prepared polymers (A1) and (A2) were characterized by FTIR and HNMR spectroscopies , physical properties were determined, intrinsic viscosities were measured.Thes two biodegradable polymers were hydrolysis in different pH values.

Keywords: Acrylate , Lactate ,biodegadable polemers.

Introductio

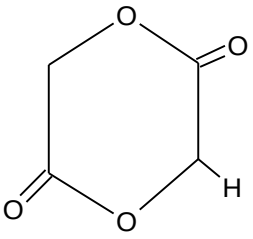
.Lactic acid(1) has a hydroxyl group adjacent to the carboxyl group , making it an alpha hydroxy acid (AHA)(1-2).



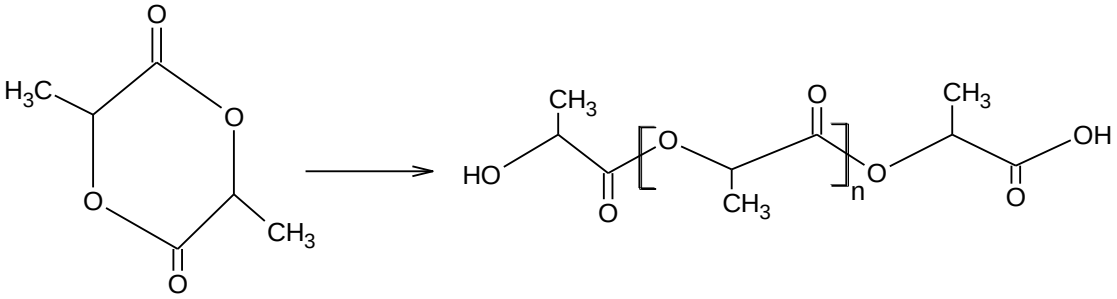
L- LACTIC ACID

In solution,it can lose a proton from the carboxyl group,producing the lactate ion , its pKa is 1 unit less, meaning lactic acid deprotonates ten times more easily than acetic acid does.This higher acidity is the consequence of the intramolecular hydrogen bridge between the hydroxyl and the carboxylate group , making the latter less capable of strongly attracting its proton(3).Lactic acid is hygroscopic.DL-lactic acid is miscible with water and with ethanol above its melting point which is around 17 or 18 Cº.In animals,L-lactate is constantly produced from pyruvate via the enzyme lactate (4),It does not increase in concentration until the rate of lactate production exceeds the rate of lactate removal , which is governed by a number of factors, including monocarboxylate transporters,concentration and isoform of LDH,and oxidative capacity of tissues.The concentration of blood lactate is usually 1-2 mmol/L at rest , but can rise to over 20 mmo/L(4,5) . This occurs due to metabolism in red blood cells that lack mitochondria,and limitations resulting from the enzyme activity that occurs in muscle fibers having a high glycolytic(1,2,3)

.Two molecules of lactic acid can be dehydrated to lactic acid can be dehydrated to lactide , a cyclic lactone.A variety of catalysts can polymerize lactide to either heteroacic or syndiotactic polylactide(6,7)



LACTIDE



Polylactic acid (PLA)is at present one of the most promising biodegradable polymer (biopolymers)and has been the subject of abundant literature over the last decade.

PLA can be processed with a large number of techniques and is commercially available(large – scale production) in a wide range of grades(7,8,10)).It is relatively cheap and has some remarkable properties , which make it suitable for different applications with the different synthesis to produce this biopolymer, its diverse properties and various applications.Its biodegradability is adapted to short-term packaging,and its biocompatibility in contact with living tissues is exploited for biomedical applications(drug encapsulation(5,6).The basic aim of prodrug design is to mask undesirable drug properties,such as low solubility in water or lipid membranes , low target selectivity,chemical instability,undesirable taste,irritation or pain after local administration,pre systemic metabolism and toxicity (6-7).In a polymer-drug conjugate , there are at least three major components : a soluble polymer backbone, a biodegradable linker,and a covalently linked anti-cancer drug which is deactivated as a conjugate system.(8-9,10,11)

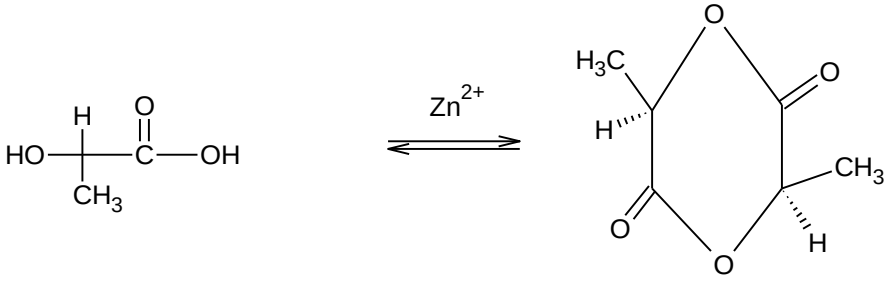
Experimental :-

Materials:-

Materials & Instruments Arganine was obtained from fluka, Lactic acid was purchased from Redial DeHaen,Zinc powder was obtained from BDH,Chloroform was obtained from GCC,NaOH 96% from BDH, Ethanol was pruchsed from BDH,Sod.Acrylate was purchased from Fluka.FTIR Spectra were recorded by (4000-400)cm on Shimadzu Spectrophotometer.Melting points were determined on Callencamp MF B-600 melting point apparatus .Electronic Spectra measurements using CINTRAS-UV visible, spectrophotometers .Thermogravimetric Analysis (TGA) carried out by Shimadzu model 50 WS thermal analysis instruments respectively(10,11,12,14) .An accurately weighted of sample was placed in an aluminum cup and sealed . The experiment consisted of heating the sample from 500C under the continues flow of dry nitrogen gas at a heating rate 10 $C^{o}min^{-1}$.H-NMRspectra wewre recorded by shimadzu.

Synthesis of lactide

The synthesis of L-lactide was carried out according to the procedure was reported with some modification including the use of Zn as catalyst.In round bottom flask equipped with condenser.Lactic acid (88gm,0.97 mol),and zinc powder(0.44gm , 0.0146 mol) were added and the mixture was stirred for 15 minute , then the mixture was heated at 130 C^{o} and the tempreture raised to about 200C^{o} with a continuous stirring under vacuum pressure under four hours .The flask content was left to cool down to room tempreture with a continuous tirring until a coloress vicose material was formed. Chloroform 100 ml was added to the rection flask , and then the content of the flask was transferred to a separatory funnel , washed with 45 ml of NaOH solution(12,13) .The organic layer was received and the solvent was evapourted under reduced pressure , alight yellow viscose was obtained with yield of 62%.



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Synthesis of vinyl lactate polymer(A1)

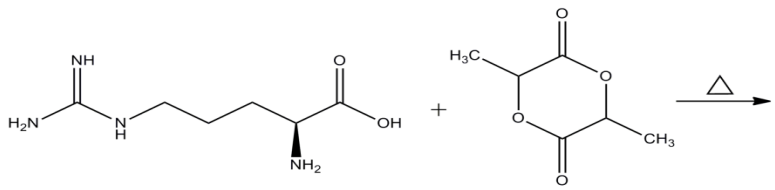
(0.146gm,0.01mole) of prepared lactide was dissolved in 5 ml of dry chloroform (0.105 gm ,0.01mole) of disloved arganine was added , the mixture was heated to 50Cº.for 1hr.The solvent was evapourated,the white product was collected with 60%,η=0.831 dL/g.

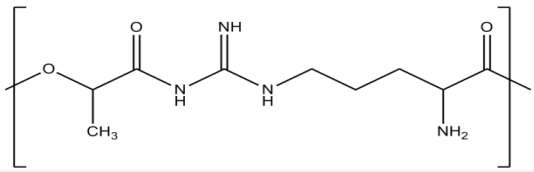
Synthesis of vinyl lactate polymer (A2)

In a round bottom flask equipped with condenser, (0.09 gm ,0.0016 mole)of poly sod.acrylate was dissolve in 5ml of acetone and (0.1gm,0.001mole of lactic acid was added,the mixture was stirred and heated at 50Cº a bout 2hr.The solvent was distilled off, the colorless polymer was isolated and washed with ether for tree times.The yield was 60%,η=0.92dl/g.

Results & Discussion:

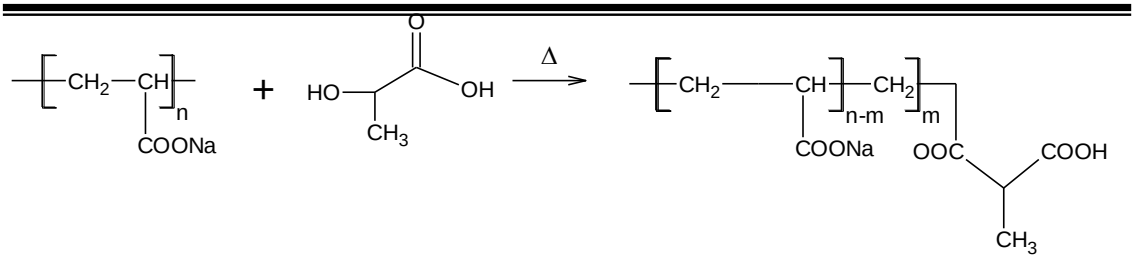
Lactate polymers were very important in industry and in medicine,we aimed to insert the lactate moiety through the back bone of the prepared polymers using two different methods.Firstly,the prepared lactide was reacted with arganine as amino acid as ring opening reaction which gave poly (ester-amide) as biopolymer(A2) according to the following reaction.





Poly(ester-amide) was containing two bioactive units and which could be used as biodegradable polymers.

Second,the modification of poly sod.acrylate with lactic acid was performed through esterification reaction for producing as biodegradable plastic.Which could be prepared according to the following equation:-



A2

Fig(1)FTIR spectrum of (A1)polymer showed the main absorptions at 3450-2860 cm-1 attriputed to -OH carboxylic acid , 1716 cm-1 due to C=O carboxylic acid , 1664 cm-1 due to C=O ester, 1573 cm-1 due to C=O sodium acrylate.(

Fig(2) FTIR spectrum of prepared polymer (A2) showed the absorption of bands at 3221cm-1 due to NH stretching of amide , 2997cm-1 inicated to CH aliphatic ,and at 1653cm-1 indicted the formation of amide attachment.

Fig(3) 1HNMR spectrum of polymer (A1) showed the singals at 1.4ppm assigned to 3H(CH3)d and 2.2-2.8 ppm assigned to CH2-CH2-CH(2H) quartet, 3.3-3.8ppm assigned to CH2CH-CO(1H)Triplet.10.5ppm assigned to OH carboxylic.

Fig(4)TGA thermogrm of (A2) polymer gave Tg=254.8Cº with weigh loss 95.7% this indicated the thermal stability of polemer.

Conclussions :-

We concluded that(A1)polymer gave poly(ester-amide) with different biounits lactate-arganine which can repeated respectively through backbone of polymer chains, also(A2) polymer.These two prepred polymers can be used in many pharmaceutical biological application,due to their biodegradability and the presence of ester and amide attachments which could enhanced the hydrolysis.

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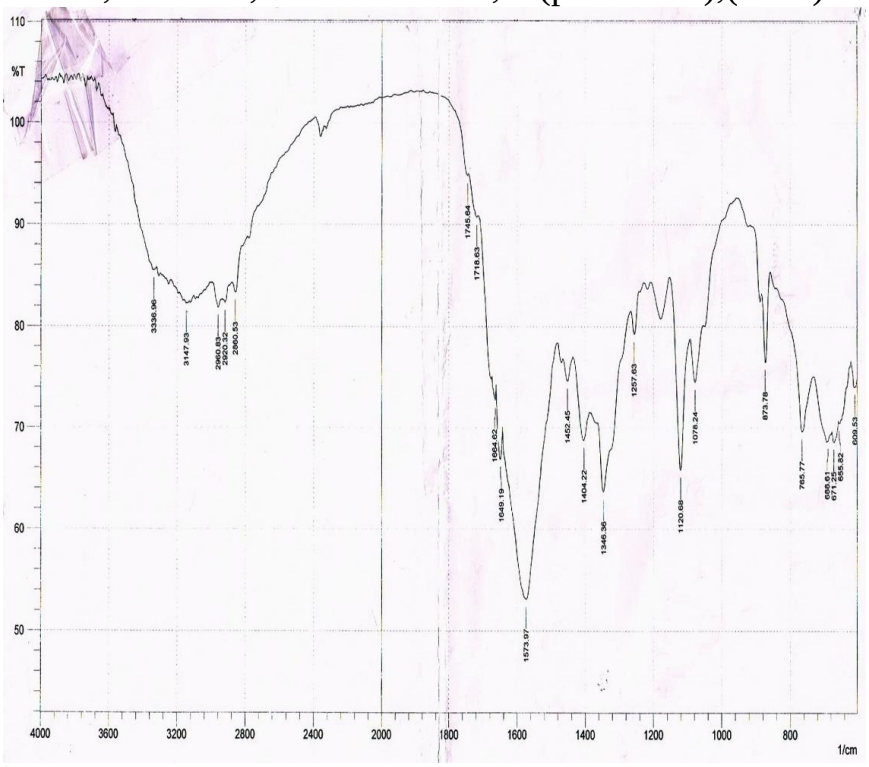
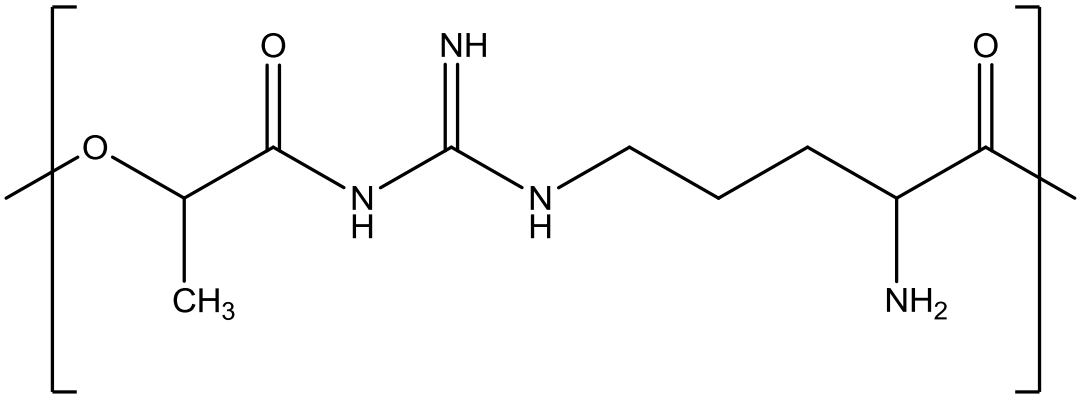
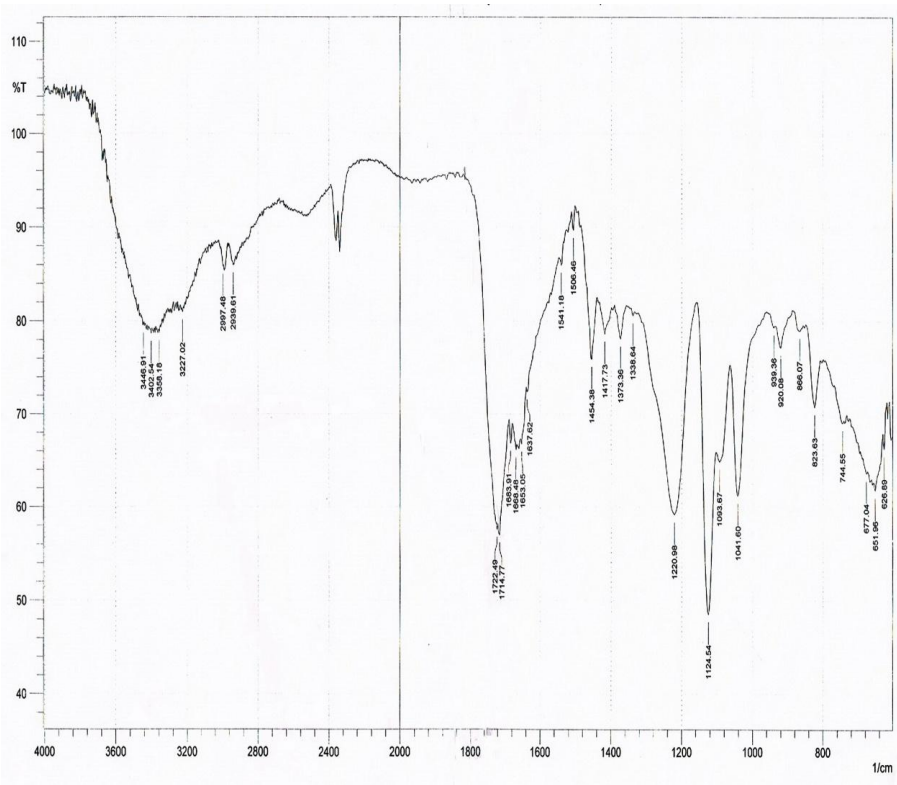
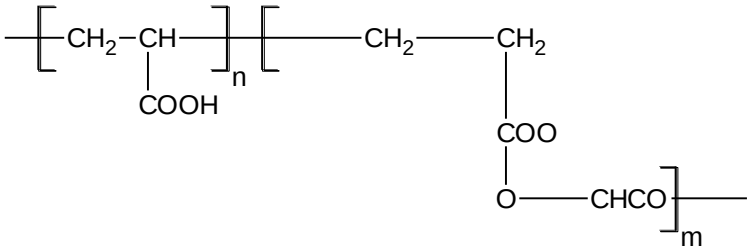


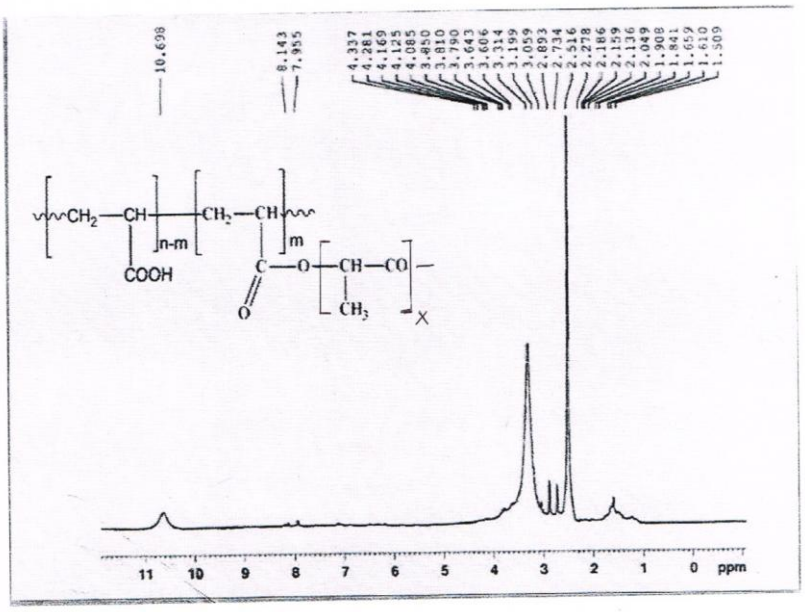
Fig(1)FTIR spectrum of lactate-argninamide polymer (A1)





Fig(2)FTIR spectrum oF poylmer(A2)





FIg(3) H-NMRspectrum of acrylic grafted lactate copolymer(A)

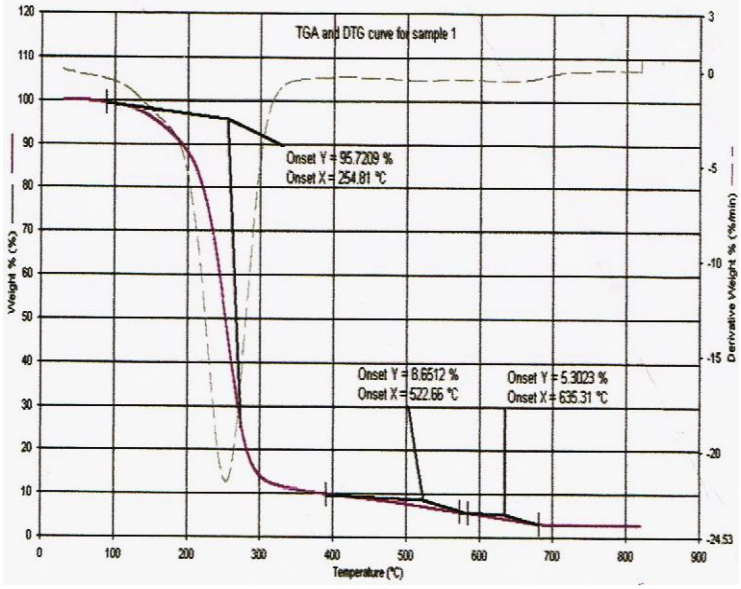


FIg (4) TGA and DTG thermo-gram for polymer (A2)

تخليق وتشخيص بعض بوليمرات اللاكتيت

الخلاصة

في هذا العمل تم تخليق اثنين من البوليمرات البيولوجية حيث بالامكان تكوين بوليمر جديد بطريقة فتح الحلقة اللاكتايد مع الارجنين للحصول على استر امايد بوليمر (A1) , حيث يطعم اللاكتيت خلال سلسلة بوليمرلحامض الاكريلك (A2) . وقد تم تشخيص كل من البوليمرات (A1) و (A2) عن طريق تقنيتين FTIR و HNMR الطيفية . كما تم تحديد الخصائص الفيزيائية واللزوجة لكل منهما . تم تحليل البوليمرات ضمن قيم مختلفة للدالة الحامضية .