Synthesis, Structure, and Antioxidant Activity of Tri and Di-Organotin Carboxylate Complexes of Tryptophan

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ABSTRACT: *Three organotin carboxylate complexes were synthesized by condensation of the reaction of methanolic tryptophan solution with Tri, and Diorganotin chloride for 3-4 hours to obtain the corresponding complexes (1-3) with good yields. These complexes were also diagnosed with several techniques, including infrared spectroscopy, Sn^{119}, and proton NMR, in addition to elemental analysis of the elements. These complexes were applied to find out the antioxidative activity of tryptophan and the prepared complexes by using DDPH and CUPRAC techniques. The results of the antioxidant activity in both ways showed that the prepared complexes are more effective than tryptophan from which they are derived. Also, complex 1 showed more anti-oxidant activity than other complexes.*

KEYWORDS*: Tryptophan; Synthesis; Antioxidant activity; Ligand; CUPRAC and DPPH method.*

INTRODUCTION

Antioxidants were used in the mid-20th century as food preservatives and were used to prevent cancer, vascular and heart diseases, and were used in nutritional supplements [1]. After that, a number of vitamins were discovered. Then vitamins were discovered [2]. Free radicals are the most common oxidizing agent. Free radicals are atoms, ions, or molecules that contain unpaired and unstable electrons that are active with other molecules in chemical reactions. In the free radicals, the single electron searches for electrons in order to stabilize itself, which leads to a chain reaction [3].

the free radicals are often derived from oxygen, sulphur and nitrogen molecules. These free radicals are parts of groups of molecules called Reactive Oxygen

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Species (ROS), Reactive Sulphur Species (RSS), and Reactive Nitrogen Species (RNS) [4,5]. In the food system, antioxidants are defined as small amounts that are able to prevent or delay the oxidation of antioxidants [6]. Therefore, they are substances that protect molecules from oxidants [7]. From a biological point of view, any molecule that can inhibit or inhibit the action of oxidants can be considered an antioxidant. Antioxidants can trap the harmful form of oxygen and prevent it from damaging cells [8]. the metallic complex consists of a central metallic atom bonded to a ligand, in coordination chemistry, where The metals can act as Lewis acids and form complexes with a variety of Lewis bases Furthermore, the denticity of the ligand used as well as its type are of particular interest, due to the coordination numbers and oxidation states that are possible to obtain for different applications and the type of arrangements around the metal ion. The nature of the donor atoms is also of important interest to the metal complexes' structure, their properties, and potential applications [9].

Organic tin complexes have received great attention due to their great structural potential and broad biological activities, such as antiviral, antibacterial, anticancer, antifungal, and anti-inflammatory; It is related to the nature of the organic fragments adhered to the tin atom [10]. Studies have shown the special importance of organic tin esters due to their excellent pharmacological importance [11-14], photo stabilizers [15-19], and gas storage [20]. In addition, the organic tin esters of amino acids are used as biocides for fungi and germs [21-23]. Organotin(IV) complexes' geometrical properties play a crucial role in their biological action, The five coordinated organotin(IV) carboxylates have been reported to have stronger anti-proliferative and LOX inhibitory action than the six coordinated ones [24], demonstrating the availability of coordination sites at Sn. The importance of the relationship between biological features and the structure of organotin(IV) carboxylates has sparked research into tin carboxylates.

One of the important amino acids is tryptophan, which is important and essential for the normal growth of children, but in adults, it is important to maintain nitrogen balance [25, 26]. In general, the main role of tryptophan for humans is the synthesis of muscle tissue and protein. Dairy products, fish, meat, bananas, eggs, chocolate, dates and peanuts are among the amino acids of tryptophan. The antioxidant ability of tryptophan isolated from breast milk was tested in order to show its ability to absorb oxygen radicals and reduce inflammatory bacteria. It was found that tryptophan isolated from human milk showed nearly 99-fold higher ORAC capacity than that of whole human milk [27, 28]. These results propose that isolated tryptophan from human milk is a powerful anti-oxidant as depicted by ORAC values. According to the above facts, tryptophan was used as a ligand with tri and di-organotin compounds to prepare new complexes that have a higher ability as an antioxidant.

EXPERIMENTAL SECTION

Preparation of Triphentl tin(IV) Complex 1

A methanolic solution of tryptophan (2mmol, 0.408gm) was stirred with (2mmol)NaOH for 30 minutes at room temperature. (2mmol, 0.77gm) from triphenyl tin chloride(Ph_3SnCl) was dissolved in 20 mL hot methanol then added to the tryptophan mixture, and left to reflux for about 4 hours with continuously stirred [15-19]. The precipitate was left to evaporate under vacuum, and washed with diethyl ether.

Preparation of di- organotin(IV) Complexes 2-3

30 mL methanolic solution of tryptophan (2mmol, 0.408gm) was stirred with (2mmol)NaOH for 30minute at room temperature. (1mmol, 0.303gm or 0.219gm) from dibutyl or dimethyltin dichloride(Bu_2SnCl_2 or Me_2SnCl_2) was dissolved in 20 mL hot methanol and then added to tryptophan mixture, left to reflux about 4 hours with continuously stirred [18-20]. The precipitate was left to evaporate under a vacuum, and washed with diethyl ether.

Antioxidant activity tests

a) DPPH technique

Antioxidant activity was measured using the DPPH technique, as described by others [29-31]. The compounds were dissolved in methanol at different concentrations of 2; 4; 8; 16, and 32 M, respectively. DPPH (0.1 mM in methanol) was added to each test solution and carefully mixed. After 30 minutes later, the solution was discarded. A UV-Vis spectrophotometer was used to test the mixture's absorbance at a wavelength of 517 nm. The proportion of inhibition against DPPH was used to calculate antioxidant activity. The Inhibition Percentage (IP) was calculated using Eq. (1);

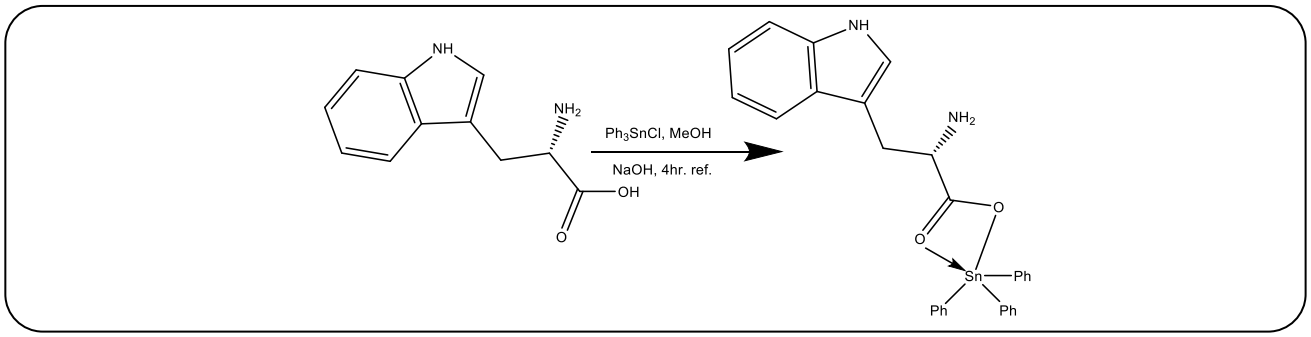

Fig. 1: Complex 1 Preparation.

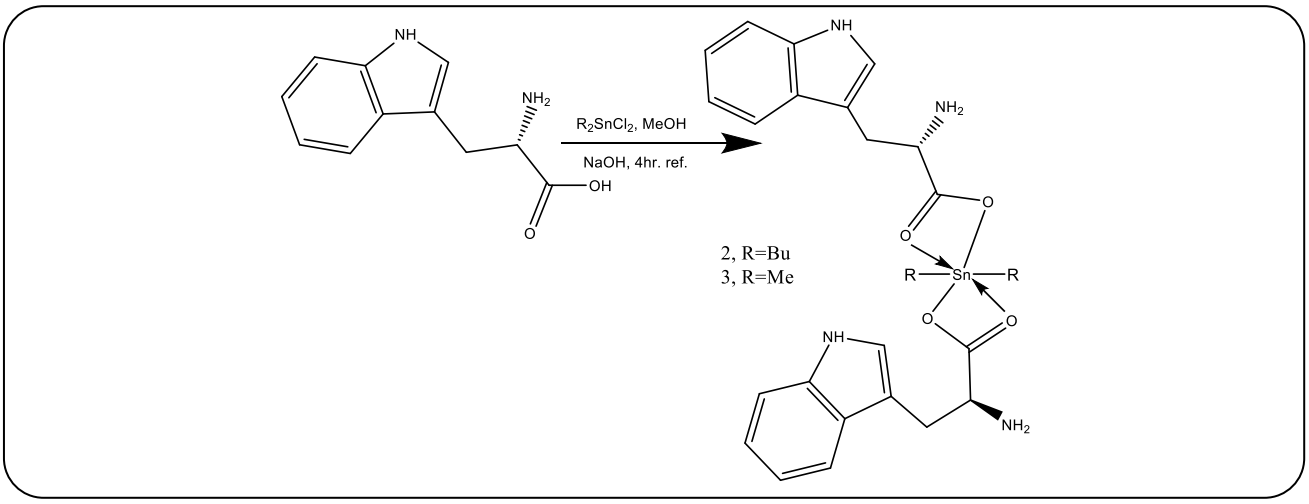

Fig. 2: Complex 2 and 3 Preparation.

$$\text{IP} = \left[\frac{\text{Control Absorbance} - \text{Sample Absorbance}}{\text{Cotrol Absorbance}}\right] \times 100 \quad (1)$$

b) CUPRAC method

The antioxidant activity test by the CUPRAC method was performed according to the method used by others [32].

$$\text{Total antioidants levals} = \left[\frac{\text{A test}}{\text{A STD}}\right] \times \text{Conce. of STD} \left(\frac{\text{mmole}}{\text{L}}\right) \quad (2)$$

RESULTS AND DISCUSSION

Synthesis of organotin(IV) complexes 1–3

The refluxing reaction of methanolic solutions of tri and di- organotin chloride with tryptophan was gave the corresponding complexes (Figs. 1 and 2) respectivily, with high yield percentage.

The resulted complexes were identfied with spectroscopy techniques of FT-IR, NMR (^{1}H and ^{119}Sn) in addition to elemental analysis. The results of each investigation are arranged in Tables 1-3.

The (IR) spectra of tryptophan complexes (1-3) revealed a large change in the wavelength of functional group vibrations when compared to the ligand, indicating that tryptophan and organotin salts are complexed [33]. In tin complexes, the stretching vibration of the O-H group was also lost, providing further evidence of complexation. In the IR spectra of complexes, new bands of Sn-C and Sn-O developed in the ranges of 520-526 and 447-448 cm^{-1} [34]. Table 2 and Fig. 3 show the FT-IR spectral data of tryptophan and complexes.

In proton – NMR spectra, the absence of a carboxyl-proton group (–CO_2H) which appears as a single replaceable piece at 13.00 ppm in the ligand spectrum confirms the formation of tin-complexes. As well as the emergence of new signals belonging to groups of phenyl butyl and methyl of the prepared complexes, as in the Fig. 4.

The spectrum of Sn^{119} complexes showed singlet signals at -187 to -260 ppm, confirming the occurrence of the complex between tryptophan and tin. The chemical shift of the Sn^{119} spectrum depended on the symmetry number and the geometric shape of the complexes [35].

Table 1: Physical Analysis Data of tryptophan and Complexes 1–3.

Compound	R	color	Yield %	MP(°C)	Elemental analysis % Calculated (Found)		
					C	H	N
L	-	white	-	290-292	64.69(63.15)	5.92(6.12)	13.72(14.02)
1	Ph_3	Yellowish-white	87.5	310-312	62.96(63.18)	4.74(5.16)	5.06(4.84)
2	Bu_2	off white	83.8	317-319	56.36(56.45)	6.31(8.85)	8.76(7.58)
3	Me_2	Off white	75.8	305-307	51.92(52.91)	5.08(6.89)	10.09(9.89)

Table 2: FT-IR Spectral Data of Complexes 1–3.

Complex	C=O		C=C	Sn-C	Sn-O
	ASYM	SYM			
1	1640	1610	1453	520	448
2	1643	1621	1455	525	447
3	1641	1612	1454	526	447

Table 3: NMR Spectral data (1H and 119Sn) of tryptophan and 1–3 Complexes.

Sn(IV) Complex	^{1}H-NMR	^{119}Sn-NMR
L	13.005(s, 1H, COOH), 11.02(s, 1H, NH), 8.92 (t, 2H, NH_2), 6.81-7.35(m, 5H, Ar), 3.04-3.42(t, 2H, CH_2), 4.2(d, 1H, CH)	--
1	11.03(s, 1H, NH), 8.94 (t, 2H, NH_2), 7.96(m, 5H, Ph), 6.84-7.39(m, 5H, Ar), 3.14-3.43(t, 2H, CH_2), 4.1(d, 1H, CH),	-187
2	11.02(s, 1H, NH), 8.93 (t, 2H, NH_2), 6.82-7.35(m, 5H, Ar), 3.05-3.42(t, 2H, CH_2), 4.2(d, 1H, CH), 0.19-2.56(Bu).	-224
3	11.02(s, 1H, NH), 8.92 (t, 2H, NH_2), 6.83-7.38(m, 5H, Ar), 3.04-3.42(t, 2H, CH_2), 4.2(d, 1H, CH), 0.63-1.78 (s, Me).	-260

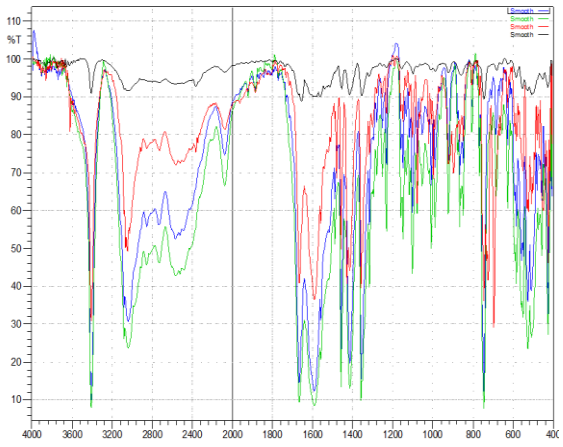

Fig. 3: FT-IR Specra of Tryptophan and (1-3) Complexes

Antioxidant Activity:

The three synthesized complexes were examined in varied quantities in the antioxidant activity analysis using the two procedures outlined. After obtaining the absorbance in each measurement, the percent inhibition can be computed; also the results may be displayed in the Figs. 5 and 6.

The results in Fig. 5 showed a high oxidation efficiency compared to the standard material used (Fig. 7).

The results showed a high antioxidant activity of the complexes prepared from tryptophan and organic tin salts compared to tryptophan alone, and this is due to the presence of the element tin, which caused an increase in the antioxidant activity[36-40]. Also, complex **1** (triphenyltin carboxylate) showed higher activity than the rest of the prepared complexes, and this may be due to the presence of three phenolic groups and an increase in the aromatic content of the complex compared to the rest of the complexes.

CONCLUSIONS

The reaction of tryptophan as a ligand with tri and diorganotin salts yielded three organotin (IV) complexes in high yeild. The tryptophan complexes were confermed

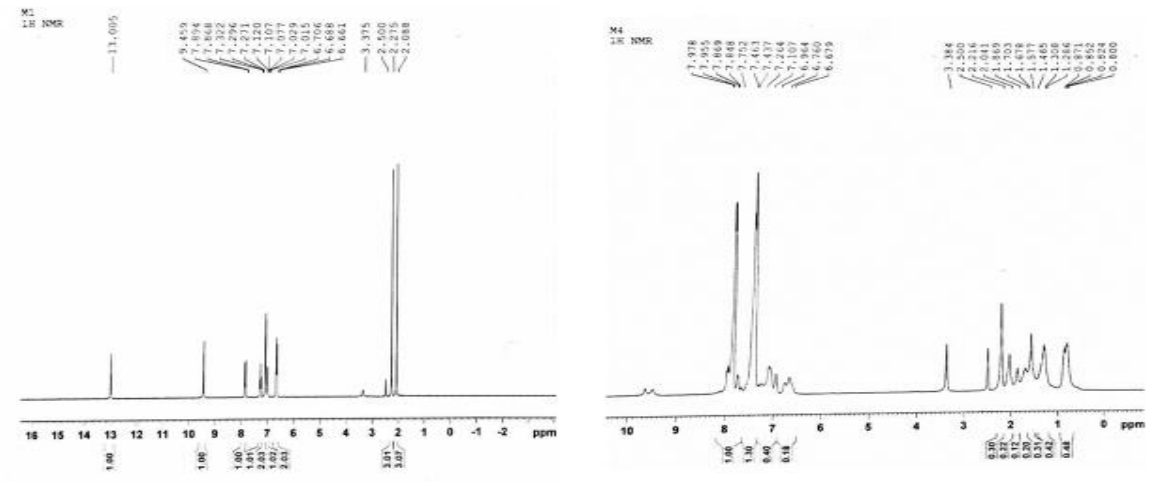

Fig. 4: ^{1}H-NMR Spectra of tryptophan and complex 2.

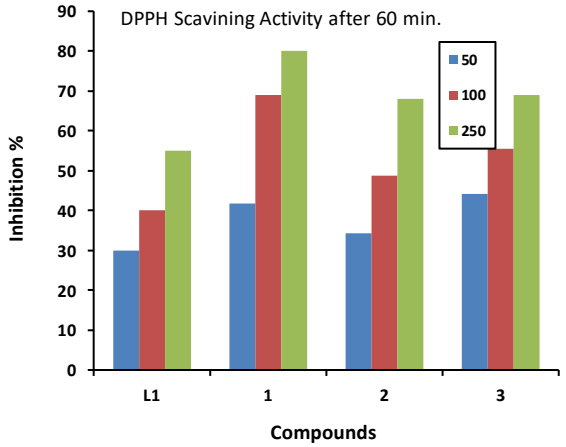

Fig. 5: DPPH scavenging activity of tryptophan and its complexes at 250 µg/mL DMSO solutions at T = 60 min.

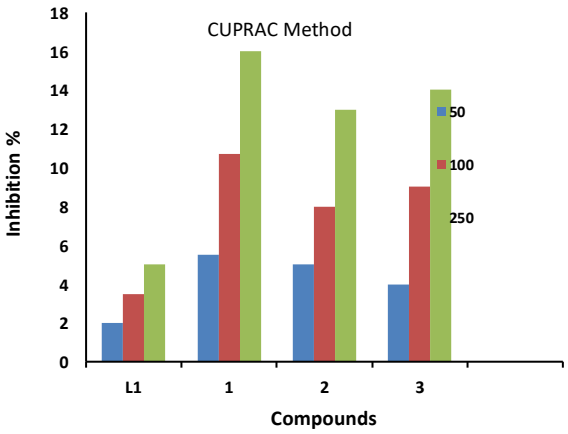

Fig. 6: CUPRAC Method activity of tryptophan and its complexes at T = 60 min.

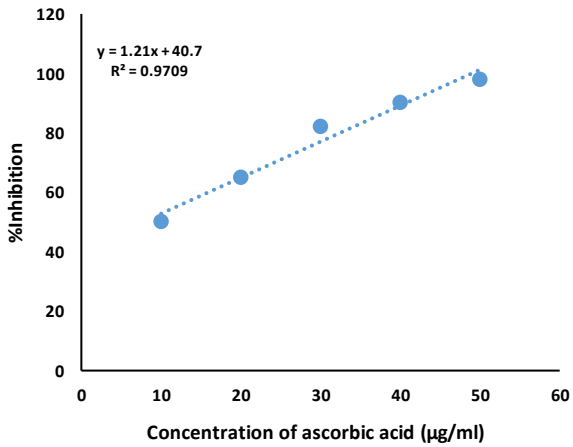

Fig. 7: Percentage Inhibition of Standard (Ascorbic Acid).

with different techniques. IR and ^{1}H –NMR spectra gave good evidence for complex formation. Also, Sn^{119}-NMR spectra of complexes proved the complexation and the geometry of complexes. The antioxidant activity of the tryptophan and its organotin(IV)complexes was determined using the DPPH and CUPRAC techniques. The antioxidant activity of the organotin(IV) complexes was found to be higher than that of the tryptophan using two approaches. Also, complex **1** of (triphenyl tin-tryptophan) was the best as compared with other complexes.

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