



A Practical Method for the Absolute Configuration Assignment of α -Amino Acids Using their Pd(dmba) Amino Acidato Complexes.

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Abstract: The reaction of α -amino acids with [Pd(dmba)(acac)] (dmba = 2-[(dimethylamino)methyl]phenyl-*C*¹,*N*; acac = acetylacetonate) gives stable amino acidato complexes [Pd(dmba)(Aa)] (Aa = *N,O*-amino acidato group) which are useful intermediates for the determination of the absolute configuration of their parent amino acids. These compounds show Cotton Effects (CE) at 265-280 nm and 305-320 nm whose sign is characteristic for the absolute configuration of the C _{α} carbon.

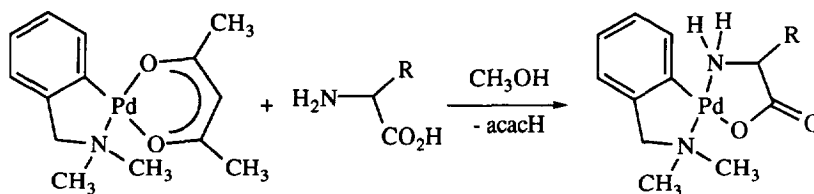
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The determination of the absolute configuration of chiral molecules has been a subject of major concern in the characterization of naturally occurring compounds and in stereoselective organic synthesis. Nowadays, with the development of new synthetic methodologies for obtaining enantiomerically pure amino acids with unusual side chains,¹ known as non-proteinogenic amino acids, the development of a rapid, accurate and easy way to determine the absolute stereochemistry of chiral amino acids is of great interest.

Circular Dichroism (CD) is especially attractive for the determination of absolute configurations, since the shape of the CD curve can provide information about the orientation of the groups around the stereogenic centre.² In particular some empirical rules have been developed to assess the absolute configuration of amino acids based on the shape of their CD curves. In this way it has been described³ that aqueous solutions of amino acids of *L*-configuration show a positive Cotton Effect band at 198-210 nm which is slightly shifted in acidic medium (205-220 nm) while for *D*-amino acids this band shows Cotton Effect of opposite sign.

One disadvantage of this method is the band position, which appears at short wavelength, so that in some cases additional chromophoric systems could have their absorptions in the same wavelength region. To override this drawback some amino acids derivatives such as *N*-2-pyridyl-*N*-oxides,⁴ thioamides,⁵ methylthioureas,⁶ thiohydantoin,⁷ *in situ* obtained organometallic molybdenum-complexes,⁸ and, recently, oxazolidinselenones⁹ have been synthesized and their behaviour in CD has been studied.

In a previous paper from this laboratory,¹⁰ it has been shown that α -amino acids easily reacted with acetylacetonato complexes [Pd(dmba)(acac)] (dmba = 2-[(dimethylamino)methyl]phenyl-*C*¹,*N*; acac = acetylacetonate) in methanol giving rise to [Pd(dmba)Aa] (Aa = *N,O*-amino acidato group) and acetylacetonate (Scheme 1). From the methanolic solutions, air-stable white solids can be isolated after solvent evaporation and diethyl ether addition to the concentrated solutions. In these complexes the amino acidato group acts as a bidentate *N,O*-ligand which restricts the conformational motion of this flexible molecule, which is very useful in the measurement of CD spectra.



Scheme 1

Now we wish to report our findings on the development of a new procedure for the determination of the absolute configuration of the C α of amino acids based on the CD spectra of their palladium-dmba complexes. The CD spectra of a wide representative set of new Pd complexes of enantiomerically pure α -amino acids of known configuration were measured at room temperature in order to establish a correlation between the stereochemistry of the amino acid ligand and the sign of the Cotton Effect at a given wavelength and the results obtained are shown in Figure 1 and Table 1. We have obtained simple CD spectra in the region 240 and 400 nm which show two characteristic bands whose Cotton Effects have opposite signs for amino acids of opposite configuration at C α . *L*-amino acid complexes gave a negative CE band at 265-280 nm and a positive CE band at 305-320 nm, while *D*-amino acid complexes showed bands of opposite sign at nearly the same wavelengths, as mirror images. Thus, these transition bands can be used as a predictive tool for configurational assignments.

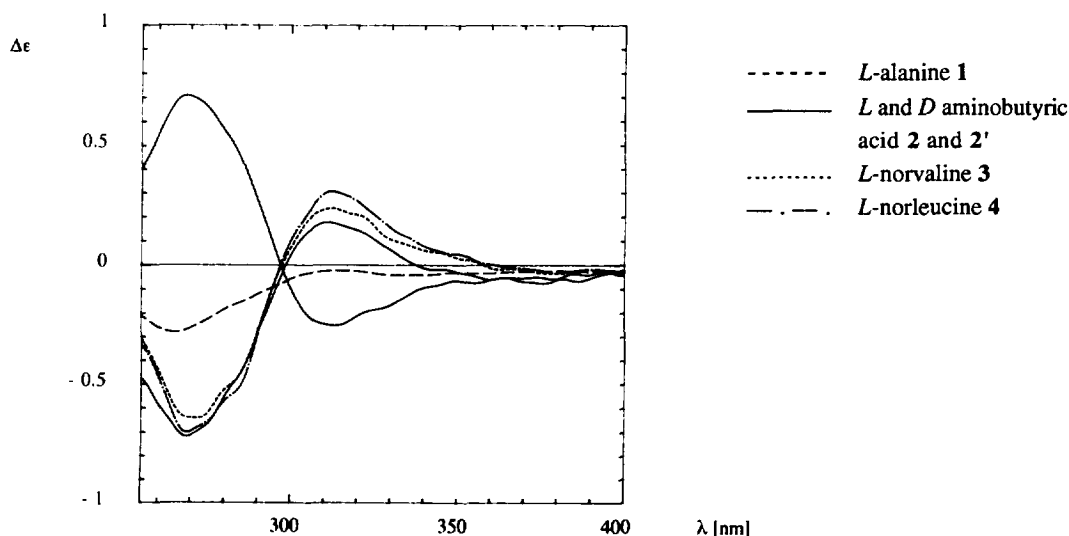


Figure 1. CD spectra of some representative complexes.

As can be seen our methodology can be applied to α -amino acids with any hydrocarbon side chain and it is compatible with the presence of some functional groups such as hydroxyl (serine and threonine), thiomethyl (methionine) or amide (asparagine, glutamine and N^6 -carbobenzoxy-lysine). However complexes of amino acids containing an additional coordinating group such as a free carboxylic acid (glutamic acid) or amine (lysine) could not be obtained. The presence of an additional stereogenic centre did not affect the sign of the Cotton Effect and the absolute configuration of the C_α carbon of amino acids such as threonine, isoleucine or alloisoleucine can be determined by this procedure.

Table 1. Circular Dichroism data of [Pd(dmba)Aa] complexes

Compound	Aa	$\Delta\epsilon^{\max}$ (λ nm)	$\Delta\epsilon^{\max}$ (λ nm)	[M] x 10 ⁻³
1	<i>L</i> -alanine	- 0.28 (266)	+ 0.06 (307)	2.24
2	<i>L</i> -2-aminobutyric acid	- 0.72 (268)	+ 0.18 (311)	2.19
2'	<i>D</i> -2-aminobutyric acid	+ 0.71 (268)	- 0.25 (313)	2.17
3	<i>L</i> -norvaline	- 0.64 (272)	+ 0.23 (312)	2.09
4	<i>L</i> -norleucine	- 0.70 (269)	+ 0.31 (312)	2.05
5	<i>L</i> -valine	- 1.04 (270)	+ 0.42 (311)	2.10
6	<i>L</i> -leucine	- 0.72 (271)	+ 0.05 (314)	2.08
7	<i>L</i> -isoleucine	- 1.14 (270)	+ 0.43 (309)	2.06
8	<i>L</i> -allo-isoleucine	- 0.92 (268)	+ 0.44 (310)	2.01
9'	<i>D</i> -phenylglycine	+ 2.26 (274)	- 0.32 (320)	1.95
10	<i>L</i> -phenylalanine	- 2.60 (278)	+ 0.96 (317)	1.90
10'	<i>D</i> -phenylalanine	+ 2.79 (277)	- 0.94 (316)	1.90
11	<i>L</i> -serine	- 0.59 (270)	+ 0.12 (316)	2.16
12	<i>L</i> -threonine	- 0.46 (274)	+ 0.09 (310)	2.09
13	<i>L</i> -methionine	- 0.69 (270)	+ 0.26 (312)	1.94
14	<i>L</i> -asparagine	- 0.44 (262)	+ 0.12 (314)	2.04
15	<i>L</i> -glutamine	- 0.65 (268)	+ 0.16 (313)	1.97
16	<i>L</i> - N^6 -Cbz-lysine	- 0.77 (269)	+ 0.30 (312)	1.57

In conclusion, the absolute configurational assignment of α -amino acids can be deduced by analysis of their Pd(dmba)(Aa) complexes. The sign of the CE bands at 265-280 nm (negative Cotton Effect = *L*- amino acid and positive Cotton Effect = *D*-amino acid) and 305-320 nm (positive Cotton Effect = *L*- amino acid and negative Cotton Effect = *D*-amino acid) are a useful tool for the determination of their absolute configuration.

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EXPERIMENTAL SECTION

Apparatus: Melting points were determined on a Gallenkamp capillary melting point apparatus and are uncorrected. IR spectra were recorded on a Perkin-Elmer 1600 FT IR infra-red spectrophotometer. ^1H NMR and $^{13}\text{C}\{^1\text{H}\}$ NMR spectra were recorded on a Varian Unity-300 or a Bruker ARX-300 spectrometer in deuteriochloroform or deuterated dimethylsulphoxide using the solvent signal as the internal standard; chemical shifts (δ) are given in parts per million and the coupling constants (J) in Hertz. Elemental analyses were performed with a Perkin-Elmer 2400 analyser. Optical rotations were measured on a Perkin-Elmer 241-C polarimeter at 25 °C. Circular Dichroism spectra were obtained from about 0.0020 M solutions of the corresponding aminoacidato complex in methanol with a computer controlled JASCO-710 spectropolarimeter under the control of the manufacturer's operating system. Spectra were collected at 0.1 nm intervals in the range 240-400 nm as the average of 2 runs using 2 s integration time and spectral band with 1 nm in 0.1 cm cuvettes.

Chemicals: All reactions were carried out under argon with magnetic stirring. Solvents were dried prior to use. *L* and *D*-amino acids were purchased from Sigma-Aldrich Chemical Co. and used as received. $[\text{Pd}(\text{dmba})(\text{acac})]$ was obtained according to the literature procedure.¹⁰

General procedure for the synthesis of compounds $[\text{Pd}(\text{dmba})(\text{Aa})]$ (*dmba* = *N,N*-dimethyldenzylamine-*C*²,*N*, *Aa* = *N,O*-amino acidato ligand). A suspension of $[\text{Pd}(\text{dmba})(\text{acac})]$ (170 mg, 0.5 mmol) and the corresponding amino acid (0.5 mmol) in methanol (30 ml) was stirred under reflux for 30 to 75 min until a colourless solution was obtained. After cooling, this solution was evaporated *in vacuo*, the residue dissolved in methylene chloride (15-40 ml) and the resulting solution filtered through a celite pad. The solution was concentrated *in vacuo* to 5 ml and diethyl ether (30 ml) was added. Subsequent stirring gave the corresponding amino acidato complex $[\text{Pd}(\text{dmba})(\text{Aa})]$ as a white solid, which was isolated by filtration.

$\{[L\text{-Alaninato-}N,O][2\text{-}[(\text{dimethylamino})\text{methyl}]\text{phenyl-}C^1,N]\text{ palladium (II)}\}$ 1. The general procedure was followed for the synthesis of 135 mg (64 % yield) of compound **1** as a white solid. M. p. , decomposed at 230 °C; $[\alpha]_{\text{D}}^{25} = -1.77$ ($c = 2.37$ in methanol); IR (Nujol) 3285, 3270, 3222, 3139, 1638 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 1.56 (d, 3H, $J = 6.8$ Hz), 2.78 (s, 3H), 2.79 (s, 3H), 2.86 (brs, 1H), 3.70-3.78 (m, 1H), 3.75 (d, 1H, $J = 14.3$ Hz), 3.80 (d, 1H, $J = 14.3$ Hz), 3.95 (brs, 1H), 6.72 (d, 1H, $J = 6.9$ Hz), 6.90-6.98 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 21.3, 51.8(2C), 55.5, 72.3, 122.1, 124.6, 125.2, 131.8, 144.4, 148.2, 180.9. Anal. Calc. for $\text{C}_{12}\text{H}_{18}\text{N}_2\text{O}_2\text{Pd}$: C, 43.85; H, 5.52; N, 8.52%. Found: C, 43.68, H, 5.38, N 8.37 %.

$\{[L\text{-2-Aminobutytrato-}N,O][2\text{-}[(\text{dimethylamino})\text{methyl}]\text{phenyl-}C^1,N]\text{ palladium (II)}\}$ 2. The general procedure was followed for the synthesis of 153 mg (71 % yield) of compound **2** as a white solid. M. p. = 202 °C (dec); $[\alpha]_{\text{D}}^{25} = +1.81$ ($c = 2.75$ in methanol); IR (Nujol) 3275, 3250, 3227, 3122, 1624 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 1.10 (t, 3H, $J = 7.5$ Hz), 1.86-2.00 (m, 1H), 2.00-2.14 (m, 1H), 2.62 (brs, 1H), 2.80 (s, 3H), 2.82 (s, 3H), 3.53-3.63 (m, 2H), 3.78 (d, 1H, $J = 14.6$ Hz), 3.84 (d, 1H, $J = 14.6$ Hz), 6.67 (d, 1H, $J = 7.2$ Hz), 6.89-7.02 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 10.2, 27.7, 51.8(2C), 61.0, 72.4, 122.2, 124.7, 125.2, 131.4, 144.4, 148.3, 179.7. Anal. Calc. for $\text{C}_{13}\text{H}_{20}\text{N}_2\text{O}_2\text{Pd}$: C, 45.56; H, 5.88; N, 8.17%. Found: C, 45.60, H, 6.23, N 8.16%.

[D-2-Aminobutyrate-N,O][2-[(dimethylamino)methyl]phenyl-C^I,N] palladium (II) 2'. The general procedure was followed for the synthesis of 170 mg (79 % yield) of compound **2'** as a white solid. M. p. = 202 °C (dec); $[\alpha]_{\text{D}}^{25} = -1.90$ ($c = 3.47$ in methanol); IR (Nujol) 3270, 3158, 1644 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 1.10 (t, 3H, $J = 7.5$ Hz), 1.86-2.00 (m, 1H), 2.00-2.14 (m, 1H), 2.59 (brs, 1H), 2.82 (s, 3H), 2.83 (s, 3H), 3.44 (brs, 1H), 3.53-3.63 (m, 1H), 3.82 (d, 1H, $J = 14.6$ Hz), 3.86 (d, 1H, $J = 14.6$ Hz), 6.67 (d, 1H, $J = 7.2$ Hz), 6.92-7.02 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 10.2, 27.7, 51.9(2C), 61.0, 72.5, 122.3, 124.7, 125.2, 131.2, 144.3, 148.3, 179.4. Anal. Calc. for $\text{C}_{13}\text{H}_{20}\text{N}_2\text{O}_2\text{Pd}$: C, 45.56; H, 5.88; N, 8.17%. Found: C, 45.42, H, 5.54, N 8.17%.

[2-[(Dimethylamino)methyl]phenyl-C^I,N][L-norvalinato-N,O] palladium (II) 3. The general procedure was followed for the synthesis of 125 mg (56 % yield) of compound **3** as a white solid. M. p. = 194 °C (dec); $[\alpha]_{\text{D}}^{25} = +10.90$ ($c = 2.32$ in methanol); IR (Nujol) 3243, 3138, 3052, 1611 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 0.96 (t, 3H, $J = 7.2$ Hz), 1.45-1.59 (m, 2H), 1.78-1.93 (m, 1H), 1.97-2.09 (m, 1H), 2.58 (brs, 1H), 2.79 (s, 3H), 2.82 (s, 3H), 3.56-3.64 (m, 1H), 3.71 (brs, 1H), 3.77 (d, 1H, $J = 14.4$ Hz), 3.83 (d, 1H, $J = 14.4$ Hz), 6.67 (d, 1H, $J = 6.9$ Hz), 6.89-7.03 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 13.8, 19.1, 36.7, 51.8(2C), 59.7, 72.4, 122.2, 124.7, 125.2, 131.4, 144.4, 148.3, 180.0. Anal. Calc. for $\text{C}_{14}\text{H}_{22}\text{N}_2\text{O}_2\text{Pd}\cdot 0.5\text{H}_2\text{O}$: C, 45.97; H, 6.34; N, 7.66%. Found: C, 45.87, H, 6.22, N 7.63%.

[2-[(Dimethylamino)methyl]phenyl-C^I,N][L-norleucinato-N,O] palladium (II) 4. The general procedure was followed for the synthesis of 175 mg (76 % yield) of compound **4** as a white solid. M. p. = 184 °C (dec); $[\alpha]_{\text{D}}^{25} = +9.98$ ($c = 2.21$ in methanol); IR (Nujol) 3237, 3144, 1624 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 0.90 (t, 3H, $J = 7.2$ Hz), 1.31-1.48 (m, 4H), 1.80-1.90 (m, 1H), 2.00-2.18 (m, 1H), 2.57 (brs, 1H), 2.80 (s, 3H), 2.82 (s, 3H), 3.50-3.54 (m, 2H), 3.78 (d, 1H, $J = 14.6$ Hz), 3.83 (d, 1H, $J = 14.6$ Hz), 6.67 (d, 1H, $J = 7.2$ Hz), 6.89-7.04 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 13.9, 22.5, 28.1, 34.5, 51.8(2C), 59.9, 72.4, 122.2, 124.7, 125.2, 131.4, 144.4, 148.4, 179.9. Anal. Calc. for $\text{C}_{15}\text{H}_{24}\text{N}_2\text{O}_2\text{Pd}$: C, 48.59; H, 6.52; N, 7.55%. Found: C, 48.27, H, 6.68, N 7.48%.

[2-[(Dimethylamino)methyl]phenyl-C^I,N][L-valinato-N,O] palladium (II) 5. The general procedure was followed for the synthesis of 134 mg (60 % yield) of compound **5** as a white solid. M. p. = 184 °C (dec); $[\alpha]_{\text{D}}^{25} = +9.72$ ($c = 2.14$ in methanol); IR (Nujol) 3238, 3136, 1601 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 1.12 (d, 6H, $J = 6.9$ Hz), 2.47-2.58 (m, 2H), 2.81 (s, 3H), 2.82 (s, 3H), 3.40 (brs, 1H), 3.46-3.50 (m, 1H), 3.78 (d, 1H, $J = 14.1$ Hz), 3.83 (d, 1H, $J = 14.1$ Hz), 6.68 (d, 1H, $J = 7.2$ Hz), 6.92-7.02 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 17.5, 19.5, 31.3, 51.8, 51.9, 64.9, 72.4, 122.1, 124.6, 125.9, 131.4, 144.5, 148.3, 179.5. Anal. Calc. for $\text{C}_{14}\text{H}_{22}\text{N}_2\text{O}_2\text{Pd}$: C, 47.13; H, 6.22; N, 7.85%. Found: C, 46.59, H, 6.49, N 7.74%.

[2-[(Dimethylamino)methyl]phenyl-C^I,N][L-leucinato-N,O] palladium (II) 6. The general procedure was followed for the synthesis of 163 mg (71 % yield) of compound **6** as a white solid. M. p. decomposed at 210 °C; $[\alpha]_{\text{D}}^{25} = +5.05$ ($c = 2.14$ in methanol); IR (Nujol) 3258, 3140, 3052, 1609 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 0.94 (d, 3H, $J = 6.4$ Hz), 0.99 (d, 3H, $J = 6.3$ Hz), 1.62-1.80 (m, 2H), 1.95-2.03 (m, 1H), 2.51 (brs, 1H), 2.81 (s, 3H), 2.83 (s, 3H), 3.54 (brs, 1H), 3.58-3.65 (m, 1H), 3.80 (d, 1H, $J =$

14.3 Hz), 3.85 (d, 1H, $J = 14.3$ Hz), 6.63 (d, 1H, $J = 7.4$ Hz), 6.90-7.04 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 21.4, 23.2, 24.9, 43.7, 51.8(2C), 58.1, 72.4, 122.2, 124.7, 125.2, 131.2, 144.3, 148.3, 180.2. Anal. Calc. for $\text{C}_{15}\text{H}_{24}\text{N}_2\text{O}_2\text{Pd}\cdot 0.5 \text{H}_2\text{O}$: C, 47.44; H, 6.63; N, 7.38%. Found: C, 47.88, H, 6.69, N 7.34%.

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-isoleucinato- N,O] palladium (II)} 7. The general procedure was followed for the synthesis of 122 mg (53 % yield) of compound **7** as a white solid. M. p. = decomposed at 224 °C; $[\alpha]_{\text{D}}^{25} = + 18.05$ ($c = 2.76$ in methanol); IR (Nujol) 3131, 3052, 1604 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 0.95 (t, 3H, $J = 7.2$ Hz), 1.12 (d, 3H, $J = 7.2$ Hz), 1.33-1.45 (m, 1H), 1.66-1.77 (m, 1H), 2.12-2.20 (m, 1H), 2.49 (brs, 1H), 2.78 (s, 3H), 2.81 (s, 3H), 3.50-3.56 (m, 1H), 3.59 (brs, 1H), 3.74 (d, 1H, $J = 14.1$ Hz), 3.80 (d, 1H, $J = 14.1$ Hz), 6.68 (d, 1H, $J = 6.9$ Hz), 6.89-7.02 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 11.9, 16.2, 24.6, 38.1, 51.8, 51.9, 64.4, 72.4, 122.2, 124.6, 125.2, 131.3, 144.6, 148.4, 179.2. Anal. Calc. for $\text{C}_{15}\text{H}_{24}\text{N}_2\text{O}_2\text{Pd}$: C, 48.59; H, 6.52; N, 7.55%. Found: C, 48.47, H, 6.86, N 7.61%.

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-allo-isoleucinato- N,O] palladium (II)} 8. The general procedure was followed for the synthesis of 136 mg (59 % yield) of compound **8** as a white solid. M. p. = 192 °C (dec); $[\alpha]_{\text{D}}^{25} = + 4.91$ ($c = 2.56$ methanol); IR (Nujol) 3243, 3144, 1611 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 0.96 (t, 3H, $J = 7.5$ Hz), 1.12 (d, 3H, $J = 6.9$ Hz), 1.29-1.50 (m, 2H), 2.20-2.32 (m, 1H), 2.59 (brs, 1H), 2.81 (s, 3H), 2.82 (s, 3H), 3.21 (brs, 1H), 3.56-3.64 (m, 1H), 3.81 (s, 2H), 6.66 (d, 1H, $J = 7.2$ Hz), 6.88-7.04 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 11.9, 14.2, 26.6, 37.4, 51.9(2C), 62.8, 72.5, 122.2, 124.7, 125.2, 131.1, 144.5, 148.4, 179.4. Anal. Calc. for $\text{C}_{15}\text{H}_{24}\text{N}_2\text{O}_2\text{Pd}$: C, 48.59; H, 6.52; N, 7.55%. Found: C, 48.03, H, 6.22, N 7.29%.

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-phenylglycinato- N,O] palladium (II)} 9'. The general procedure was followed for the synthesis of 204 mg (85 % yield) of compound **9'** as a white solid. M. p. = 120 °C; $[\alpha]_{\text{D}}^{25} = - 72.36$ ($c = 1.99$ in methanol); IR (Nujol) 3230, 1631 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 2.67 (brs, 1H), 2.77 (s, 3H), 2.83 (s, 3H), 3.68 (d, 1H, $J = 14.1$ Hz), 3.77 (d, 1H, $J = 14.1$ Hz), 4.69 (dd, 1H, $J = 6.4$ Hz, $J = 2.7$ Hz), 5.03 (brs, 1H), 6.65 (d, 1H, $J = 6.9$ Hz), 6.81-6.99 (m, 3H), 7.24-7.36 (m, 3H), 7.71-7.78 (m, 2H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 51.8, 52.0, 63.7, 72.2, 122.0, 124.5, 125.2, 127.4, 128.3, 129.0, 132.0, 139.2, 144.3, 148.3, 179.0. Anal. Calc. for $\text{C}_{17}\text{H}_{20}\text{N}_2\text{O}_2\text{Pd}\cdot \text{H}_2\text{O}$: C, 49.95; H, 5.42; N, 6.85%. Found: C, 50.17, H, 5.30, N 6.88%.

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-phenylalaninato- N,O] palladium (II)} 10. The general procedure was followed for the synthesis of 207 mg (84 % yield) of compound **10** as a white solid. M. p. = 203 °C (dec); $[\alpha]_{\text{D}}^{25} = + 35.33$ ($c = 3.21$ in methanol); IR (Nujol) 3283, 3217, 1617 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 2.52 (brs, 1H), 2.68 (s, 3H), 2.75 (s, 3H), 3.24 (dd, 1H, $J = 14.6$ Hz, $J = 10.2$ Hz), 3.47 (dd, 1H, $J = 14.6$ Hz, $J = 3.5$ Hz), 3.60 (d, 1H, $J = 14.1$ Hz), 3.66 (d, 1H, $J = 14.1$ Hz), 3.78-3.88 (m, 2H), 6.49 (d, 1H, $J = 6.9$ Hz), 6.82-7.02 (m, 3H), 7.24-7.35 (m, 5H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 40.5, 51.6, 51.7, 61.1, 71.9, 122.1, 124.6, 125.2, 127.3, 129.1, 129.5, 131.8, 136.8, 144.1, 148.3, 179.6. Anal. Calc. for $\text{C}_{18}\text{H}_{22}\text{N}_2\text{O}_2\text{Pd}$: C, 53.41; H, 5.48; N, 6.92%. Found: C, 53.07, H, 5.08, N 6.82%.

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*D*-phenylalaninato- N,O] palladium (II)} 10'. The general procedure was followed for the synthesis of 198 mg (80 % yield) of compound **10' as a white solid. M. p. = 203 °C (dec); $[\alpha]_D^{25} = -36.44$ ($c = 3.40$ in methanol); IR (Nujol) 3281, 3217, 1620 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 2.52 (brs, 1H), 2.76 (s, 3H), 2.80 (s, 3H), 3.24 (dd, 1H, $J = 14.1$ Hz, $J = 10.5$ Hz), 3.47 (dd, 1H, $J = 14.1$ Hz, $J = 3.6$ Hz), 3.70 (d, 1H, $J = 14.1$ Hz), 3.76 (d, 1H, $J = 14.1$ Hz), 3.79-3.90 (m, 2H), 6.46 (d, 1H, $J = 7.5$ Hz), 6.83-7.02 (m, 3H), 7.24-7.37 (m, 5H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 40.5, 51.6, 51.7, 61.1, 72.0, 122.1, 124.6, 125.2, 127.4, 129.1, 129.5, 131.8, 136.8, 144.0, 148.3, 179.4. Anal. Calc. for $\text{C}_{18}\text{H}_{22}\text{N}_2\text{O}_2\text{Pd}$: C, 53.41; H, 5.48; N, 6.92%. Found: C, 53.28, H, 5.23, N 6.81%.**

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-serinato- N,O] palladium (II)} 11. The general procedure was followed for the synthesis of 196 mg (91 % yield) of compound **11 as a white solid. M. p. decomposed at 200 °C; $[\alpha]_D^{25} = -5.10$ ($c = 1.47$ in methanol); IR (Nujol) 3283, 3125, 1635 cm^{-1} ; ^1H NMR ($\text{DMSO-}d_6$, 300 MHz) δ 2.70 (s, 6H), 3.25-3.30 (m, 1H), 3.61-3.66 (m, 2H), 3.88 (s, 2H), 3.96 (brs, 1H), 4.96 (brs, 1H), 5.00 (brs, 1H), 6.80-6.94 (m, 4H); ^{13}C NMR ($\text{DMSO-}d_6$, 75 MHz) δ 51.2(2C), 60.7, 63.0, 71.5, 121.6, 123.7, 124.3, 132.8, 145.8, 148.6, 177.9. Anal. Calc. for $\text{C}_{12}\text{H}_{18}\text{N}_2\text{O}_3\text{Pd}$: C, 41.81; H, 5.26; N, 8.13%. Found: C, 41.69, H, 5.11, N 8.05%.**

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-threoninato- N,O] palladium (II)} 12. A slight modification of the general procedure (isolation was done by addition of hexane to the concentrated solution of the aminoacidato complex in methylene chloride) was followed for the synthesis of 147 mg (65 % yield) of compound **12 as a white solid. M. p. decomposed at 160 °C; $[\alpha]_D^{25} = -3.00$ ($c = 2.09$ in methanol); IR (Nujol) 3370, 1598 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 1.32 (d, 3H, $J = 6.6$ Hz), 2.78 (s, 3H), 2.79 (s, 3H), 3.30 (brs, 1H), 3.41-3.50 (m, 1H), 3.74-3.85 (m, 1H), 3.72 (d, 1H, $J = 14.2$ Hz), 3.82 (d, 1H, $J = 14.2$ Hz), 3.98 (brs, 1H), 4.42 (brs, 1H), 6.74 (d, 1H, $J = 7.2$ Hz), 6.88-7.01 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 19.8, 51.7, 51.9, 64.6, 67.6, 72.3, 122.1, 124.6, 125.2, 131.7, 144.0, 148.1, 178.6. Anal. Calc. for $\text{C}_{13}\text{H}_{20}\text{N}_2\text{O}_3\text{Pd}$: C, 43.53; H, 5.62; N, 7.81%. Found: C, 43.46, H, 5.56, N 7.62%.**

{[2-[(Dimethylamino)methyl]phenyl- C^I,N][*L*-methioninato- N,O] palladium (II)} 13. A slight modification of the general procedure (the reaction was performed at 40 °C for 5 min) was followed for the synthesis of 165 mg (69 % yield) of compound **13 as a white solid. M. p. = 172 °C; $[\alpha]_D^{25} = +39.37$ ($c = 0.80$ in methylene chloride); IR (Nujol) 3220, 3105, 1627 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz) δ 2.12 (s, 3H), 2.13-2.21 (m, 1H), 2.32-2.42 (m, 1H), 2.67-2.86 (m, 2H), 2.80 (s, 3H), 2.81 (s, 3H), 3.60 (brs, 1H), 3.75-3.84 (m, 4H), 6.71 (d, 1H, $J = 7.5$ Hz), 6.88-7.03 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 15.4, 31.5, 32.1, 51.8(2C), 60.1, 72.3, 122.2, 124.7, 125.2, 131.7, 144.4, 148.3, 179.3. Anal. Calc. for $\text{C}_{14}\text{H}_{22}\text{N}_2\text{O}_2\text{PdS}$: C, 43.25; H, 5.70; N, 7.20; S, 8.25%. Found: C, 43.02, H, 5.78, N 7.16; S, 8.36%.**

{[*L*-Asparaginato- N,O][2-[(dimethylamino)methyl]phenyl- C^I,N] palladium (II)} 14. The general procedure was followed for the synthesis of 143 mg (62 % yield) of compound **14 as a white solid. M. p. decomposed at 210 °C; $[\alpha]_D^{25} = -25.22$ ($c = 1.00$ in methanol); IR (Nujol) 3421, 3302, 3230, 3158, 1683, 1604 cm^{-1} ; ^1H NMR ($\text{DMSO-}d_6$, 300 MHz) δ 2.48-2.66 (m, 2H), 2.71 (s, 6H), 3.48-3.56 (m, 1H), 3.87 (d, 1H, $J = 14.4$ Hz), 3.93 (d, 1H, $J = 14.4$ Hz), 4.66 (brs, 2H), 6.79-6.97 (m, 5H), 7.37 (brs, 1H); ^{13}C NMR ($\text{DMSO-}d_6$, 75 MHz) δ 38.0, 51.1, 51.2, 56.1, 71.4, 121.6, 123.6, 124.3, 132.6, 145.9, 148.6, 173.4.**

177.9. Anal. Calc. for $C_{13}H_{19}N_3O_3Pd$: C, 42.00; H, 5.15; N, 11.30%. Found: C, 41.73, H, 5.01, N 11.25%.

{[2-[(Dimethylamino)methyl]phenyl-*C*¹,*N*][*L*-glutaminato-*N*,*O*] palladium (II)} 15. A slight modification of the general procedure (the aminoacidato complex was insoluble in methylene chloride and was isolated by filtration) was followed for the synthesis of 202 mg (85 % yield) of compound **15** as a white solid. M. p. = 194 °C (dec); $[\alpha]_D^{25} = +9.38$ (c = 0.84 in methanol); IR (Nujol) 3408, 3285, 3206, 3131, 1691, 1619 cm^{-1} ; ¹H NMR (DMSO-*d*₆, 300 MHz) δ 1.76-1.89 (m, 1H), 1.93-2.06 (m, 1H), 2.16-2.22 (m, 1H), 2.30-2.42 (m, 1H), 2.71 (s, 6H), 3.14-3.22 (m, 1H), 3.86 (d, 1H, J = 14.4 Hz), 3.90 (d, 1H, J = 14.4 Hz), 4.46 (brs, 1H), 4.90 (brs, 1H), 6.78-6.95 (m, 5H), 7.34 (brs, 1H); ¹³C NMR (DMSO-*d*₆, 75 MHz) δ 29.6, 31.8, 51.1(2C), 58.6, 71.4, 121.4, 123.5, 124.1, 133.0, 146.1, 148.6, 174.5, 178.9. Anal. Calc. for $C_{14}H_{21}N_3O_3Pd$: C, 43.59; H, 5.49; N, 10.89%. Found: C, 43.26, H, 5.47, N 10.73%.

{[2-[(Dimethylamino)methyl]phenyl-*C*¹,*N*][*L*-*N*⁶-carboboxylyl-lysinato-*N*,*O*] palladium (II)} 16. The general procedure was followed for the synthesis of 243 mg (80 % yield) of compound **16** as a white solid. M. p. = 126 °C; $[\alpha]_D^{25} = +5.66$ (c = 2.40 in methanol); IR (Nujol) 3315, 3276, 3233, 1702 cm^{-1} ; ¹H NMR (CDCl₃, 300 MHz) δ 1.48-1.53 (m, 2H), 1.80-2.20 (m, 4H), 2.77 (s, 6H), 3.07 (brs, 1H), 3.14-3.22 (m, 1H), 3.52-3.56 (m, 1H), 3.62 (brs, 1H), 3.74 (d, 1H, J = 14.5 Hz), 3.80 (d, 1H, J = 14.5 Hz), 4.97 (d, 1H, J = 12.5 Hz), 5.03 (d, 1H, J = 12.5 Hz), 5.24 (brs, 1H), 6.76 (d, 1H, J = 7.3 Hz), 6.85-7.00 (m, 3H), 7.24-7.34 (m, 5H); ¹³C NMR (CDCl₃, 75 MHz) δ 22.2, 29.6, 33.8, 40.1, 51.8(2C), 59.3, 66.5, 72.3, 122.1, 124.5, 125.1, 128.0, 128.5, 131.8, 136.6, 144.5, 148.2, 156.9, 180.2. Anal. Calc. for $C_{23}H_{31}N_3O_4Pd$: C, 53.13; H, 6.01; N, 8.08%. Found: C, 53.21, H, 5.73, N 8.21%.

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