XANTHOCHROIC REACTION IN SELECTED INDIAN MEDICINALLY IMPORTANT *PHELLINUS* SPECIES (APHYLLOPHOROMYCETIDAE)

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Abstract : A xanthochroic reaction in sixteen Indian *Phellinus* species was studied. It is presumed to be due to a set of pigments (mainly polymerized phenolic compounds) and not due to a single specific pigment. Therefore, absorption spectra of aqueous, ethanol and methanol-HCl extracts from 16 basidiocarps of *Phellinus* were studied spectrophometrically. All the samples showed darkening (xanthochroic reaction) to varying intensity on alkalization. The absorption spectra of the samples pigment extract were more or less similar with steeply declining curve with out any maxima, minima or upsurge. Water extracts of *Ph. badius*, *Ph. lloydii* and ethanolic extract of *Ph. aureobrunneus*, *Ph. coffeatoporus*, *Ph. griseoporus* showed weak reaction whereas, more intense reaction was observed in ethanolic extract of *Ph. lloydii* and both aqueous and ethanolic extracts of *Ph. merrillii*, *Ph. minutiporus* and *Ph. orientalis*. The degree of darkening of ethanol extract differed than that of aqueous extract. Phenol contents in water, ethanol and methanol:HCl extract were in a range of 2.9 to 7.64, 6.32 to 19.94 and 14.38 to 26.41 mg $100g^{-1}$ respectively. Based on the spectroscopic data it may be concluded that the pigments in the study samples may be related to styrylpyrones particularly hispidin or analogue of hispidin.

Key Words **- Hymenochaetales, *Phellinus*, xanthochroic reaction, hispidin, styrylpyrone**

I. INTRODUCTION

The basidiocarps in Aphyllophorales were subdivided according to the shape and hymenial configuration till early 20th century. Then after, mycologists began to realign taxa according to detailed microscopic characters. In-spite of this, the taxonomic position of family Hymenochataceae and its genera was under disagreement (Parmasto 1985; Lamrood and Góes-Neto 2006). Presence of xanthochroic basidiocarp was revealed as one of the typical characteristics of the family Hymenochaetaceae besides presence of setae and clampless hyphae. A xanthochroic basidiocarp is 'a basidiocarp with yellowish brown contextual and tramal hyphae when observed in water or acid mount, but permanently and noticeably darkens when moistened with alkaline (potassium hydroxide) solution (Parmasto and Parmasto 1979). Hence, a bold step taken to study the xanthochroic reaction and eventually the pigments, besides *Série des Igniaires* of Patouillard and *Série des Astérostromes* of Donk, and a special importance was given to the pigments in order to clear up the disputable problems of the taxonomy of the fungi belonging to Hymenochaetaceae (Parmasto and Parmasto 1979; Fiasson 1982). Colour of the context is widely considered as an important character and used in the taxonomy of Aphyllophorales at species and generic levels.

In case of Hymenochaetaceae, only suppositions were available about the composition of pigment and the pigments were studied only in few cases (see table 1) (cited from Parmasto and Parmasto 1979). Shivrina et al. (cited from Parmasto and Parmasto 1979) reported accumulation of an amorphous dark brown coloured substance (humin-like compounds) during oxidative condensation of lignin molecule by polypores.

It was further revealed that many pore fungi accumulate amorphous high molecular weight substance having few properties of humic acid. White rot fungi contain much more lignin-like substance than other wood rotting species.

Findings of aforementioned study and that of Fiasson (1982) supports the view that the brown or brownish colour of xanthochroic basidiocarp of including *Phellinus* is imparted not by one pigment of certain composition, but by a set of pigments, representing a polymerized phenolic compound. 'Colour' is a macroscopic and subjective feature and almost the same colour may be produced by pigments of different chemical nature and same may be case with pigments of *Phellinus*, as well (Fiasson 1982; Lee and Yun 2011).

TABLE 1: PIGMENTS EXTRACTED AND STUDIES FROM SOME HYMENOCHAETACEAE MEMBERS.

Name of the fungus	Pigment	Comment	Reference*
Polyporus (= *Inonotus*) *hispidus*	isolated water and ethanol soluble yellow pigment	The absorption spectra are without any characteristic feature and absorption bands were missing.	Zopf, 1889
Polyporus (=*Phellinus*) *igniarius*	reddish-brown pigment	resembling polyporic acid but soluble in water and taking intense colouration in 0.5 to 5 % KOH solution.	Nadson, 1891
Polyporus (= *Inonotus*) *hispidus.*	hispidin (4-hydroxy-6-styryl-2-pyrone)	phenolic pigments of the hispidin type	Edward *et al.*, 1961
P. pini var. *abietis* f. *laricis* (= *P. chrysoloma*) and *P. igniarius.*	isolated pigments belonging to flavonoids	to the group chalcones and aurones	Yefimenko and Ageyenkov , 1965
Armillariella mellea, P. igniarius and *P. tremulae*	characterized the pigments as melanines.	They asserted that these pigments are similar and may be separated in to four fractions, analogous to the fractions of other natural melanines and the main group of humic substances.	Mamama *et al.*, 1975
P. inginarius	phenolic compound	formed by the oxidative polymerization of a molecule containing 3,4-dihydroxy-phenyl moiety.	Kirk *et al.*, 1975
Phellinus pomaceous P. robustus var. *robiniae*.		3-14- bihispidinyl hispholomin B	Fiasson *et al.*, 1977

*Source: Parmasto and Parmasto, 1979.

II. Material and Methods:

Sample Collection:

Samples were collected from various regions of Western Maharashtra like Pune, Alibaugh, Dapoli, Karnala, Kolhapur, Mumbai, Adali, Sawantwadi, Kankavali, Nardave, Ratnagiri, Harihareshwar, Deorukh, brought into laboratory, dried at $40^0 – 45^0$C to constant weight and stored at cool, dry place in airtight container. Specimen were deposited to Herbaria Poonensis, Department of Botany, University of Pune under the accession number **'PH'**. Details of identification as described by Lamrood and Mungikar (2007), briefly, free hand thin sections were first treated with 10% KOH to afford the swelling of different hymenial structures and stained with 1% (w/v) cotton blue in lactophenol. Permanent slides were prepared in polyvinyl alcohol (PVA) medium and observed under Olympus BX 40 microscope attached with HAMAMATSU 3CCD color camera C6157 and UVP. The identification of specimens was done using a key suggested by Larsen and Cobb-Poulle (1990). Colour scheme of Jordan *et.al.* (1995) was used to describe colour of pileal, and hymenial surface, margin etc.

Preparation of Extract:

The samples were prepared according to Parmaso and Parmasto (1979) and Fiasson (1982) as follows: 100 mg powder of sample was transferred to clean test tubes and poured over by 10 ml of the extraction solvent like distilled water, ethanol and a mixture of methanol and concentrated HCl (94:6 v/v) separately. The resultant suspensions were then heated on a water bath at 60–65 ºC. Ethanol and methanol–HCl extracts were heated for 20 min while distilled water extract for 1 hour. The extracts were then kept at 18–20 ºC for 24 h and centrifuged at 5000X *g* for 20 min.

Spectrophorometric analysis:

The extracts thus obtained were screened spectrophotometrically within a range of 320–650 nm wavelength using Shimadzu UV–VIS type UV-1601 spectrophotometer (Shimadzu, Japan). After obtaining absorption spectra, the samples of water and ethanol extracts were alkalized by adding 0.2 ml of NH_4OH diluted with equal parts of distilled water. The xanthrochroic coefficient **(x)** was calculated using formula **x** = E' : E

Where,

E' – optical density of alkalized extract

E – optical density of non - alkalized extract

Optical densities at two properly selected wavelength 350 and 450 nm were used for the calculation.

The extracts were also estimated for the total phenol contents as per the method of Sadasivam and Manikam (1991). Briefly, 0.2 ml aliquot of each extract was pipetted in test tube and the total volume was made to 3 ml by adding distilled water. Then 0.5 ml of Folin- Ciocalteau reagent was added to each test tube. After three minutes, 2 ml of 20% Na_2CO_3 was added to each tube and after thorough mixing the tubes were kept in boiling water bath for exactly 1 min. Development of blue colour was observed. The solution was then cooled to room temperature and absorbance at 650 nm was measured against a reagent blank. Catechol (0.1mg /ml) was used as standard. A standard curve was prepared using different concentrations (0.2 to 1.0 ml aliquots) of catechol and the total phenol content was expressed as mg $100g^{-1}$ of material.

III. Results:

Basidiocarps of sixteen *Phellinus* samples, *Phellinus adamantinus* (Berk.) Ryvarden, *Phellinus aureobrunneus* J.E.Wright & Blumenf., *Phellinus badius* (Cooke) G. Cunn., *Phellinus coffeatoporus* Kotl. et Pouz., *Phellinus crocatus* (Fr.) Ryvarden., *Phellinus fastuosus* (Lév.) S. Ahmad, *Phellinus griseoporus* D.A. Reid, *Phellinus linteus* (Berkeley & M. A. Curtis) Teng, *Phellinus lloydii* (Cleland) G.Cunn., *Phellinus melanodermus* (Pat.) M. Fidalgo., *Phellinus merrillii* (Murrill) Ryvarden, *Phellinus minutiporus* (Bomb. et, Herr.), *Phellinus orientalis* Bondartseva & S. Herrera, *Phellinus pappianus* (Bres.) Ryvarden, *Phellinus sublinteus* (Murr.) Ryv. (=*Inonotus luteoumbrinus* (Romell) Ryvarden), *Phellinus torulosus* (Pers.) Bourdot & Galzin were used in the present study.

Absorption spectra of aqueous, ethanol and methanol–HCl extracts of these samples were studied spectrophotometrically (see fig. 1–16).

Spectroscopic analysis revealed that the absorption spectra of the basidiocarp pigment extract had curves without any maxima or minima or inflections. However, the compound in the basidiocarp showed the reaction and intensive absorption mostly in the region of 330–350 nm as well as in some cases up to 500–530 nm. But, in the most of cases the absorption was observed in the region of 330–350 nm upon the alkalization of the extract. The obtained curves showed unspecificity with respect to the type of extract.

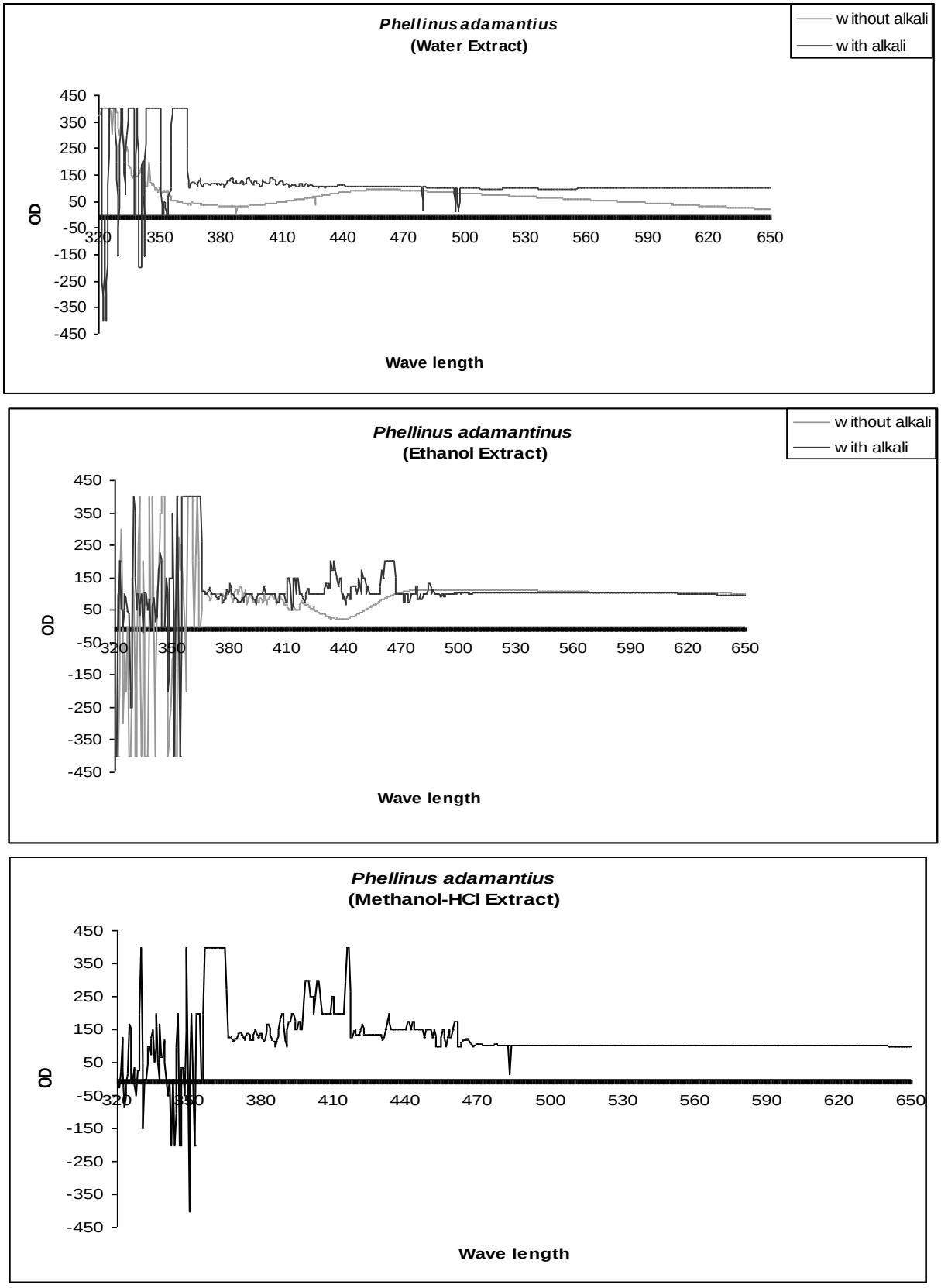


Fig 1: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. adamantius*

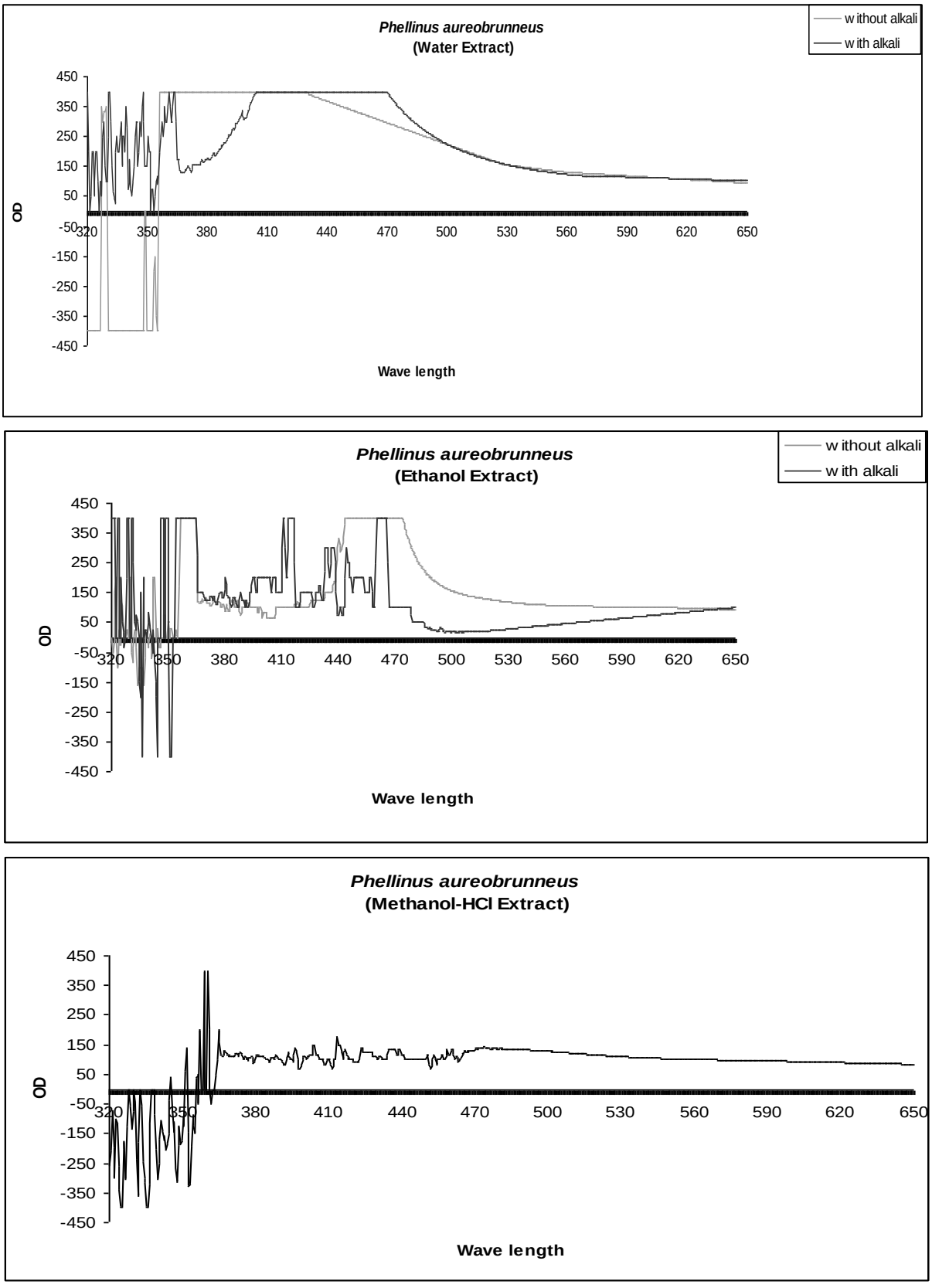
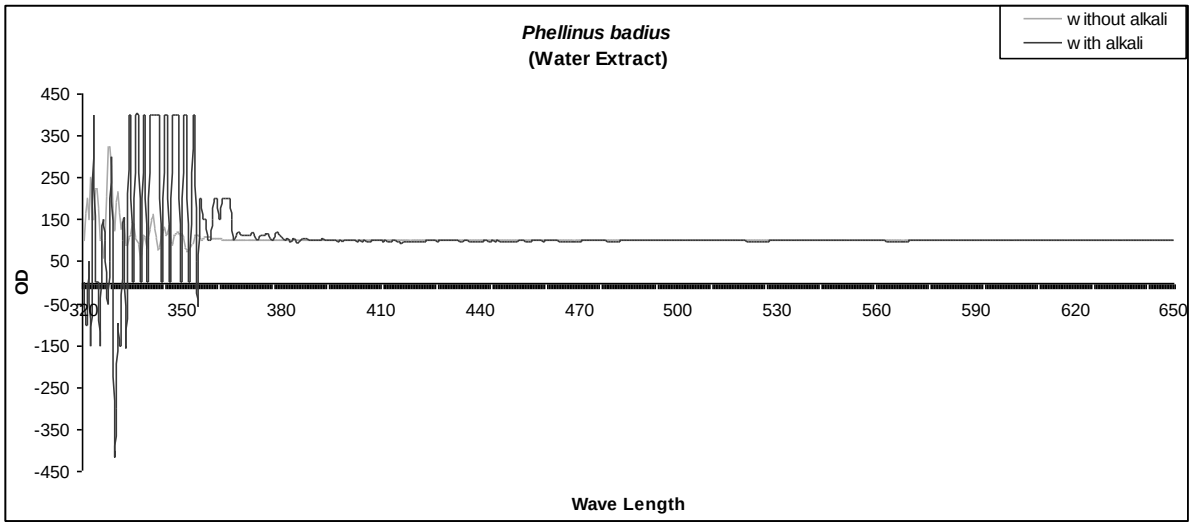
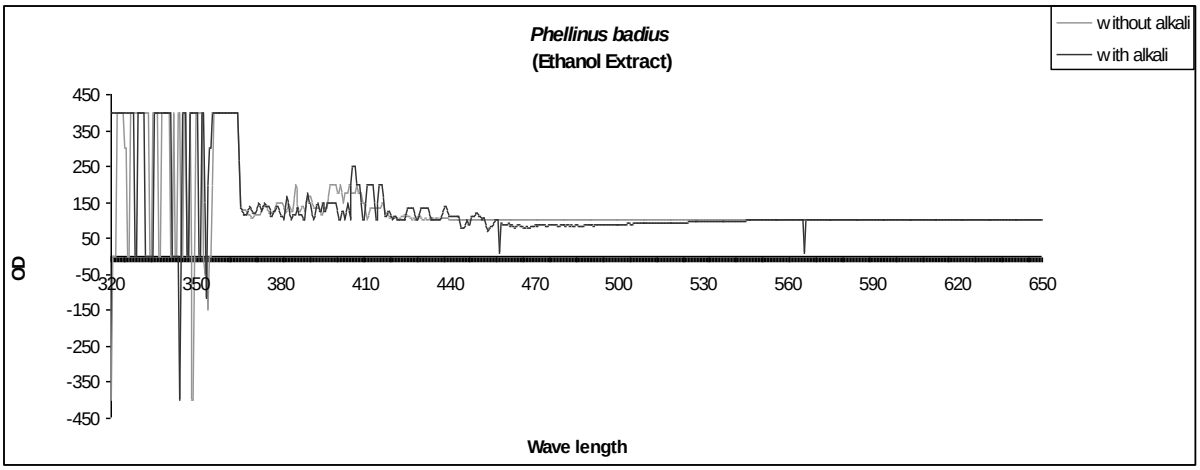


Fig. 2: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. aureobrunneus*





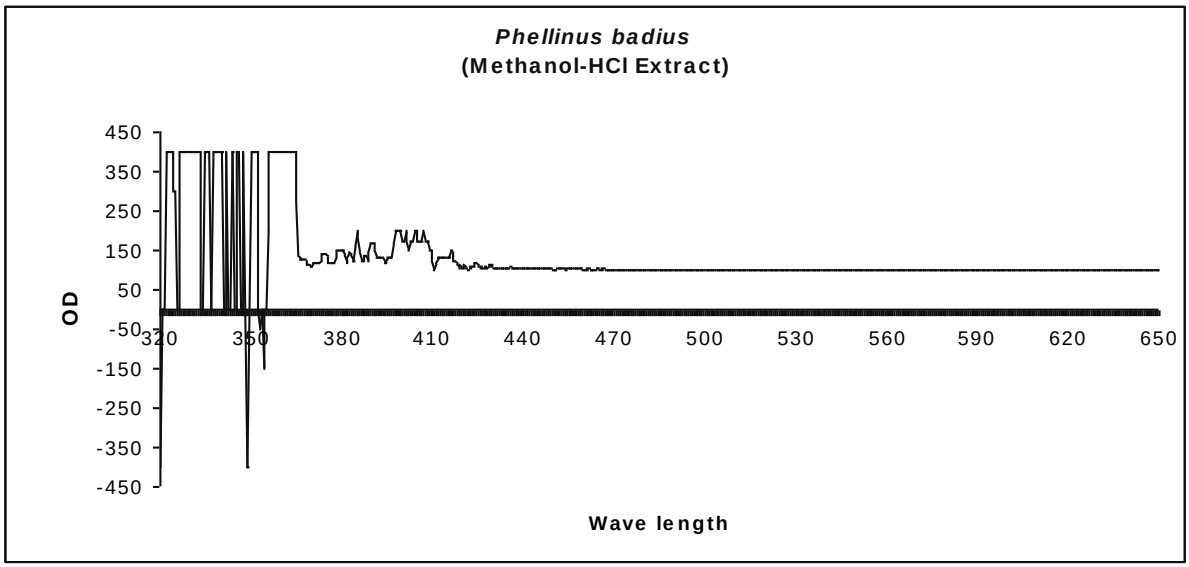
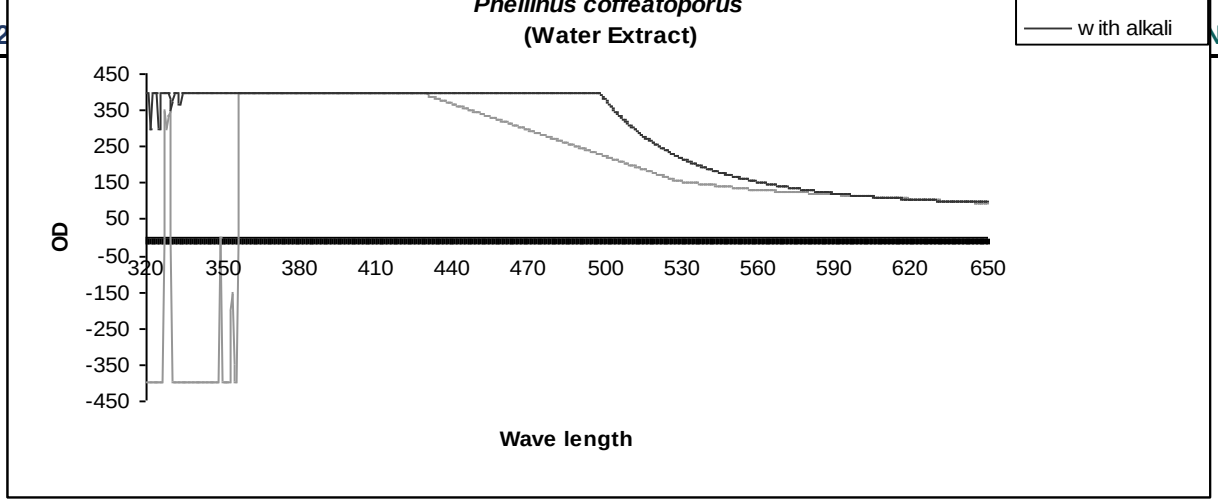
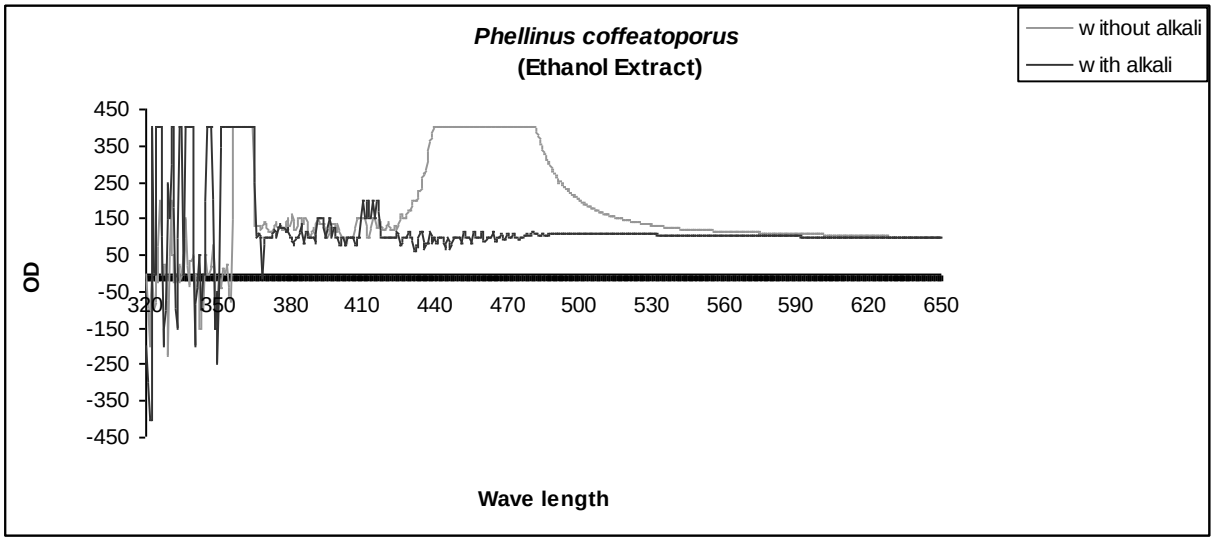


Fig. 3: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. badius*





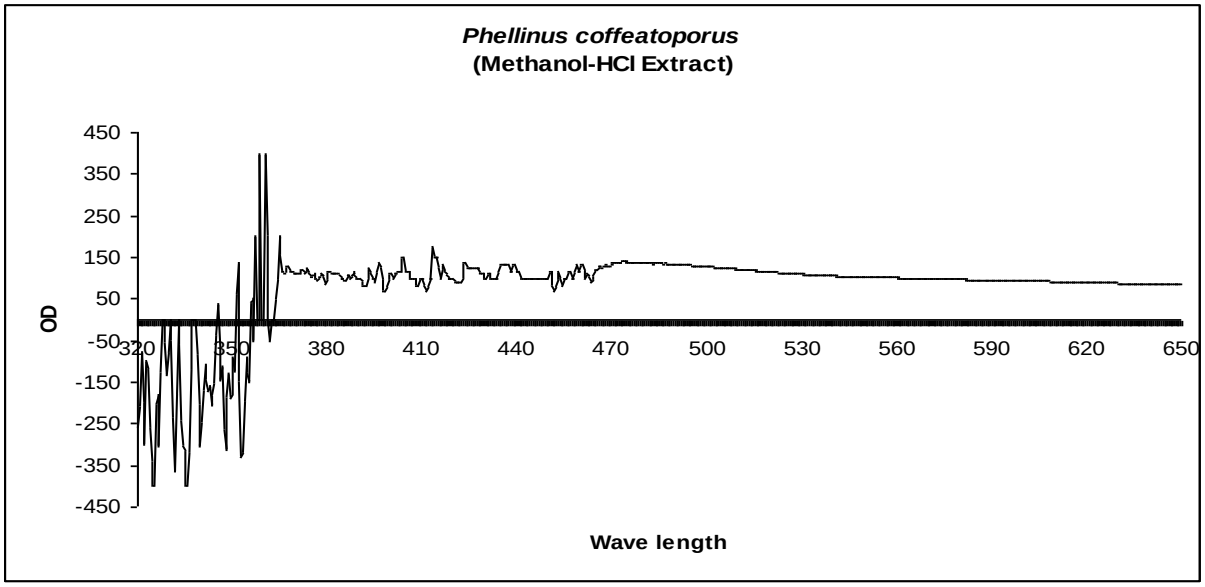
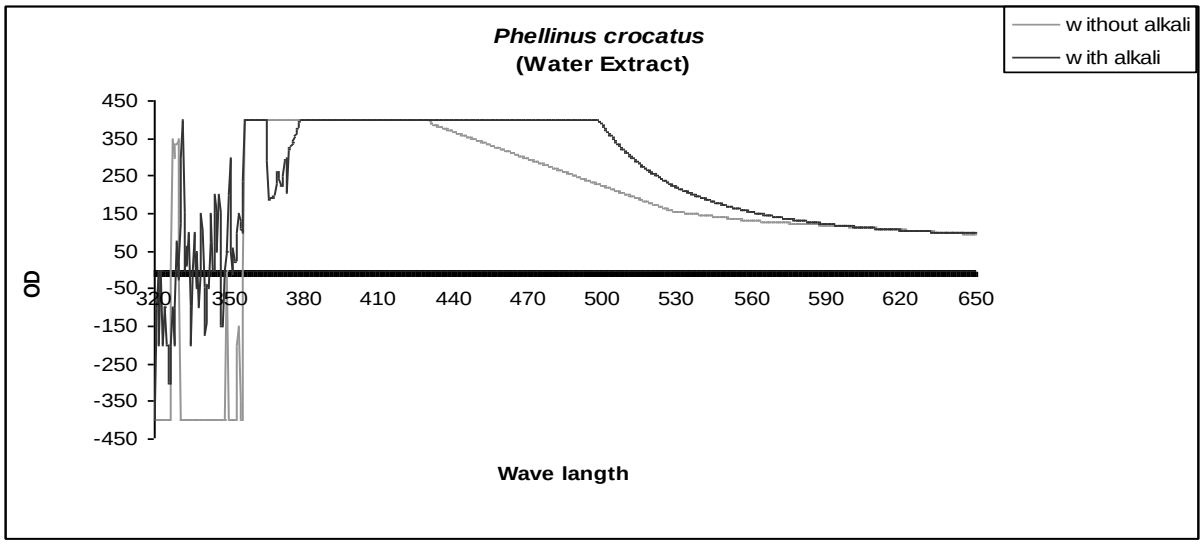
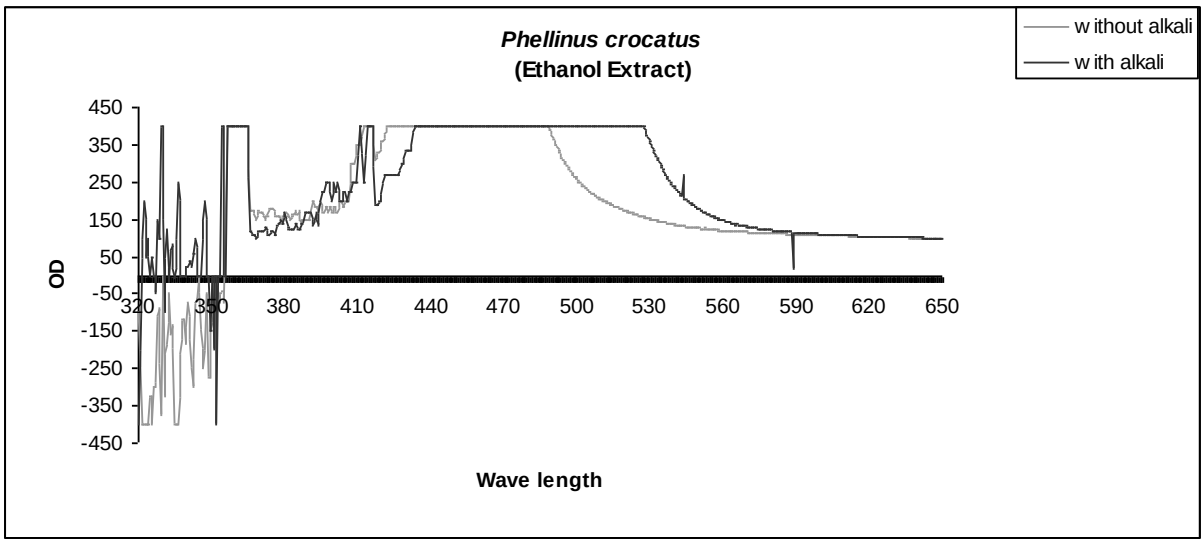


Fig. 4: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of **Ph. coffeatoporus**





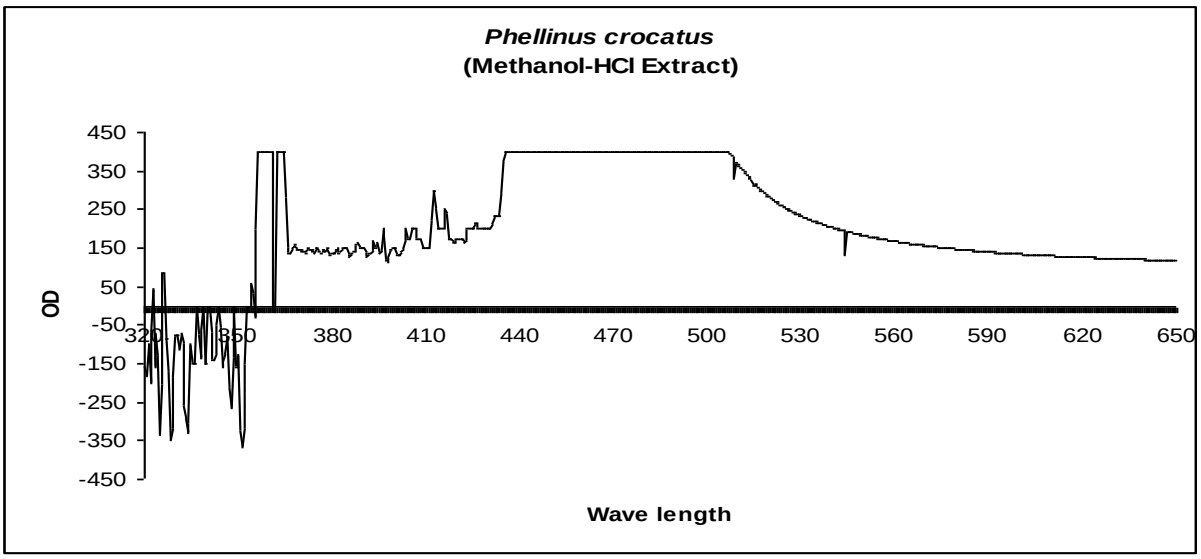
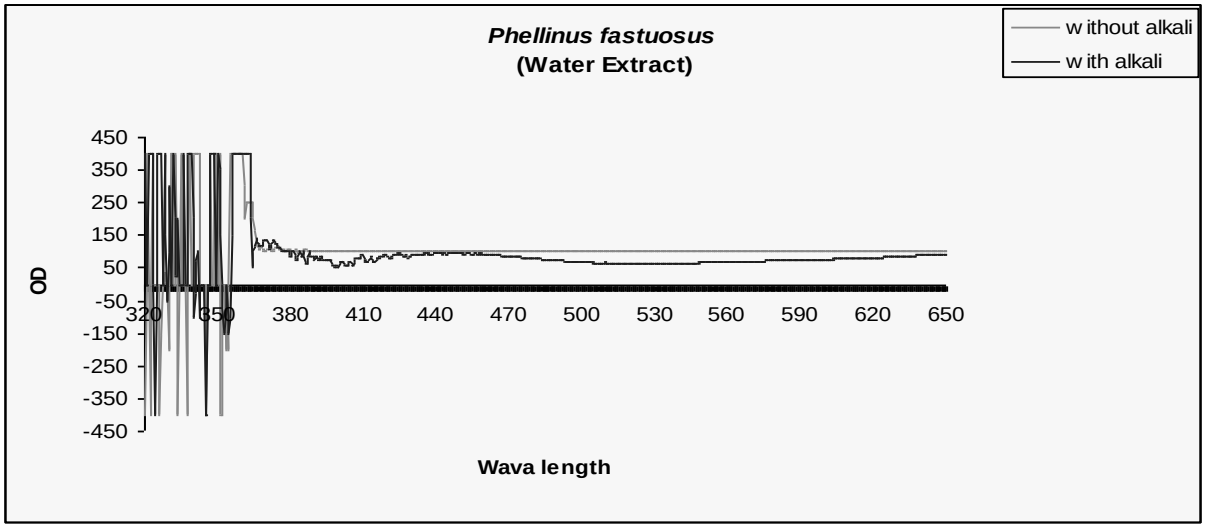
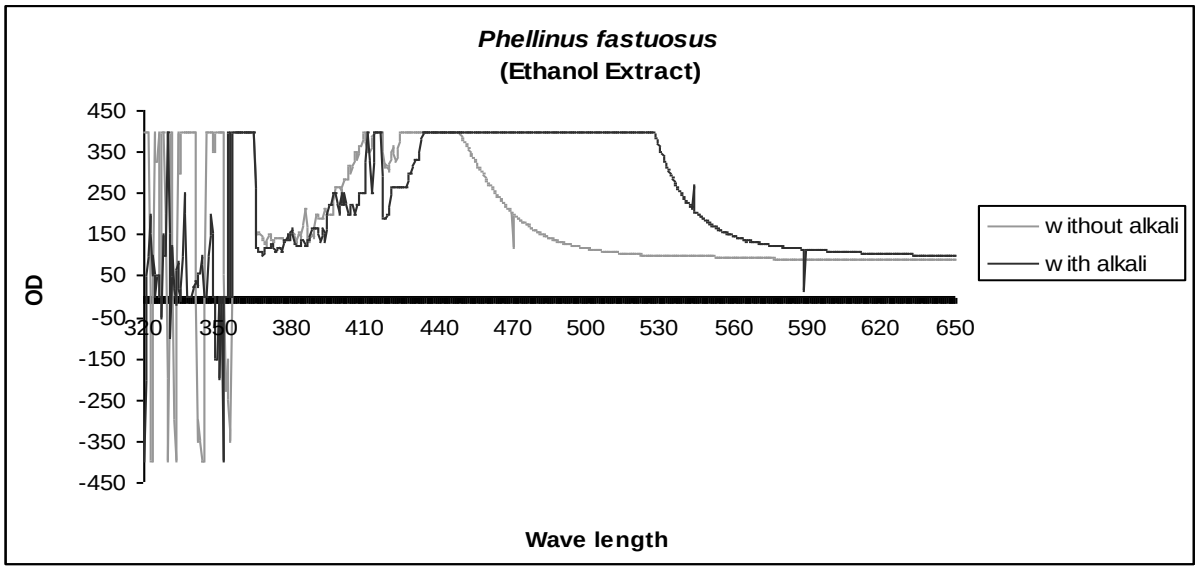


Fig. 5: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. crocatus*





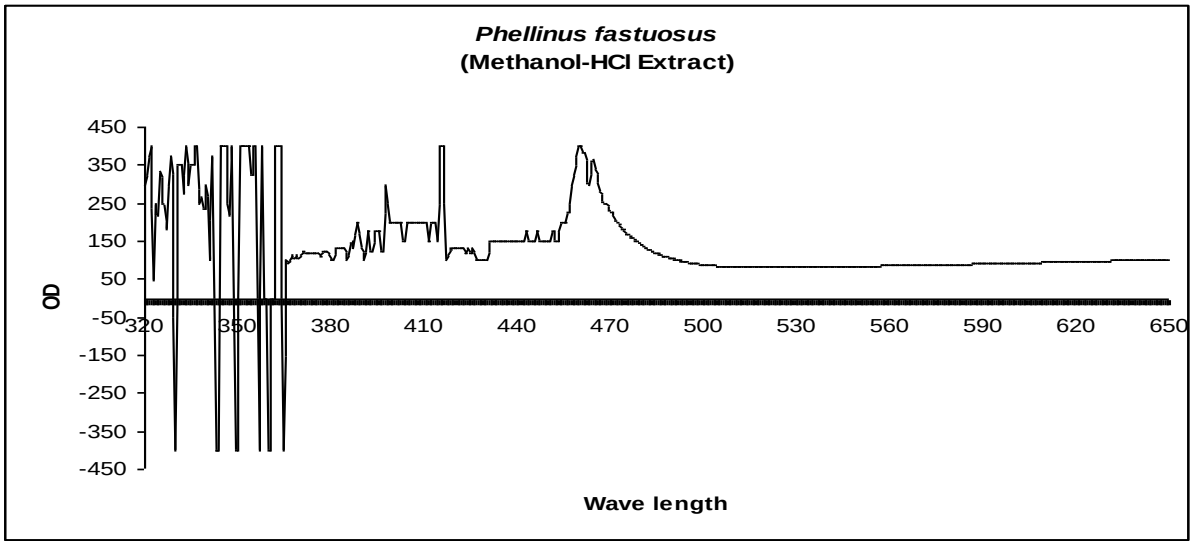


Fig. 6: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. fastuosus*

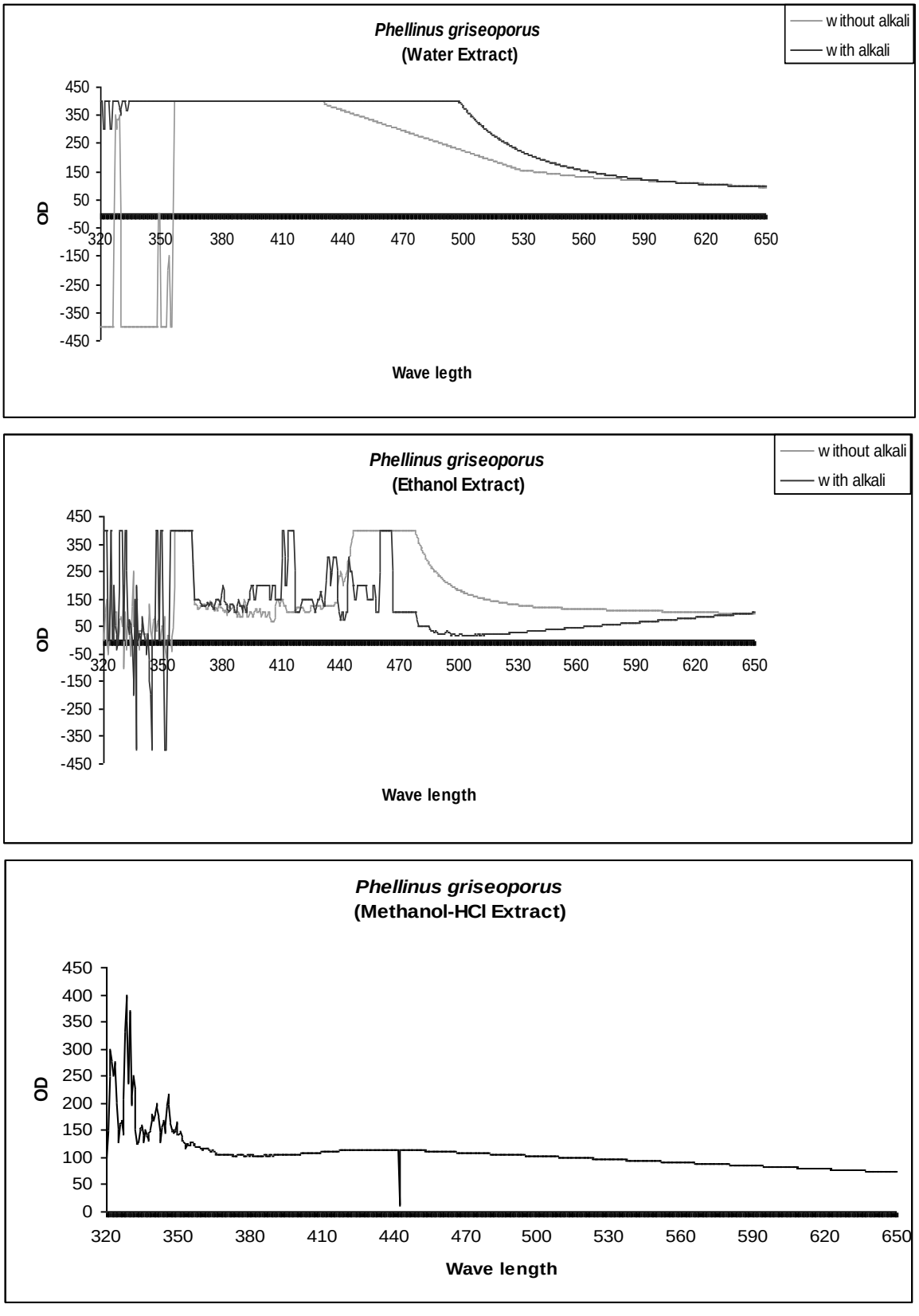


Fig. 7: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. griseoporus*

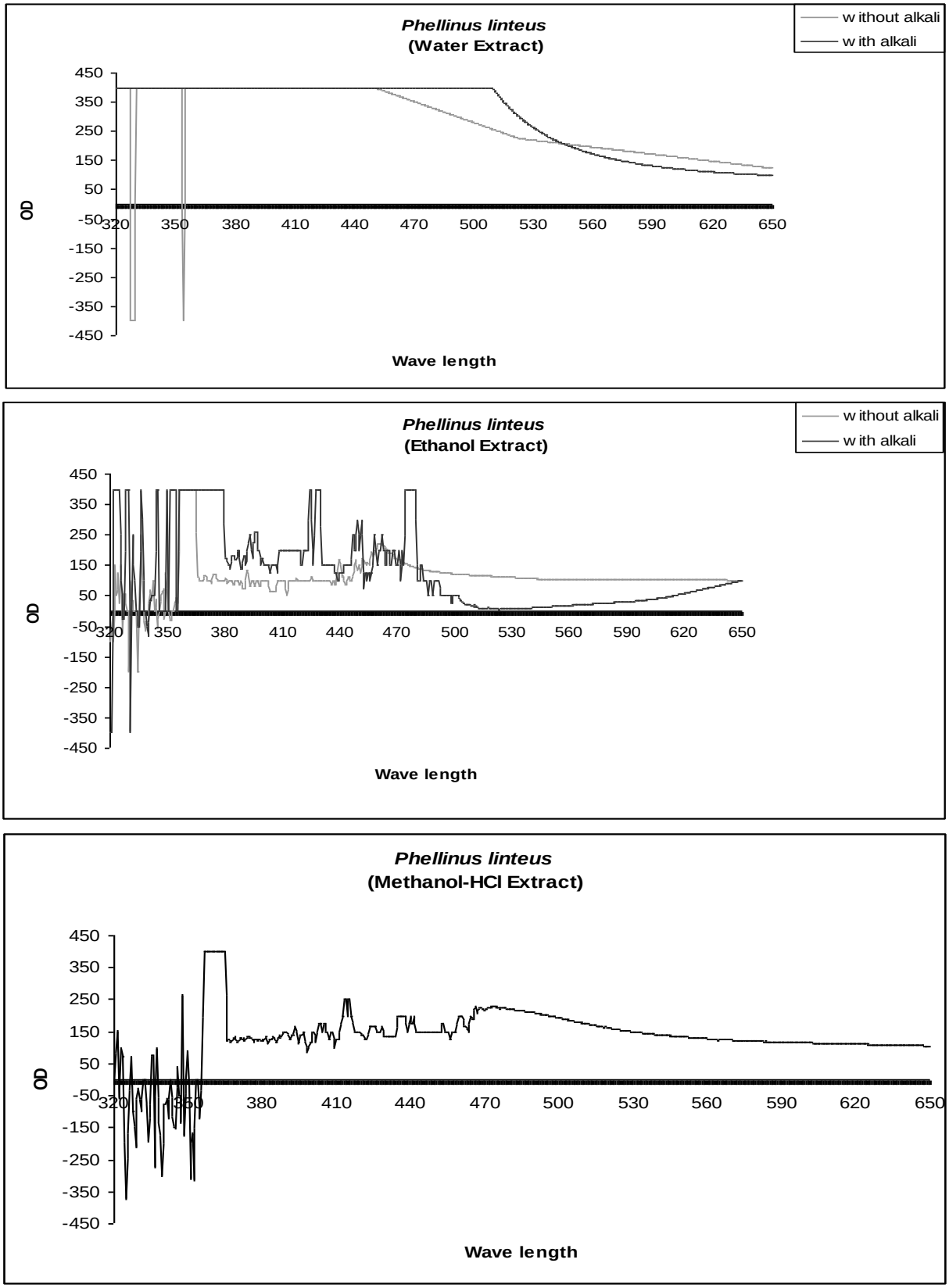
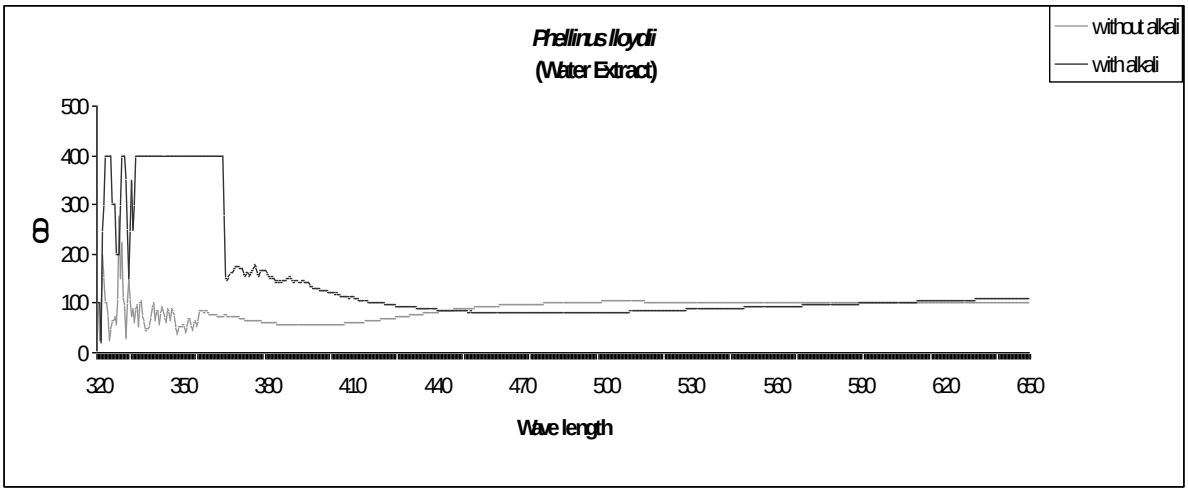
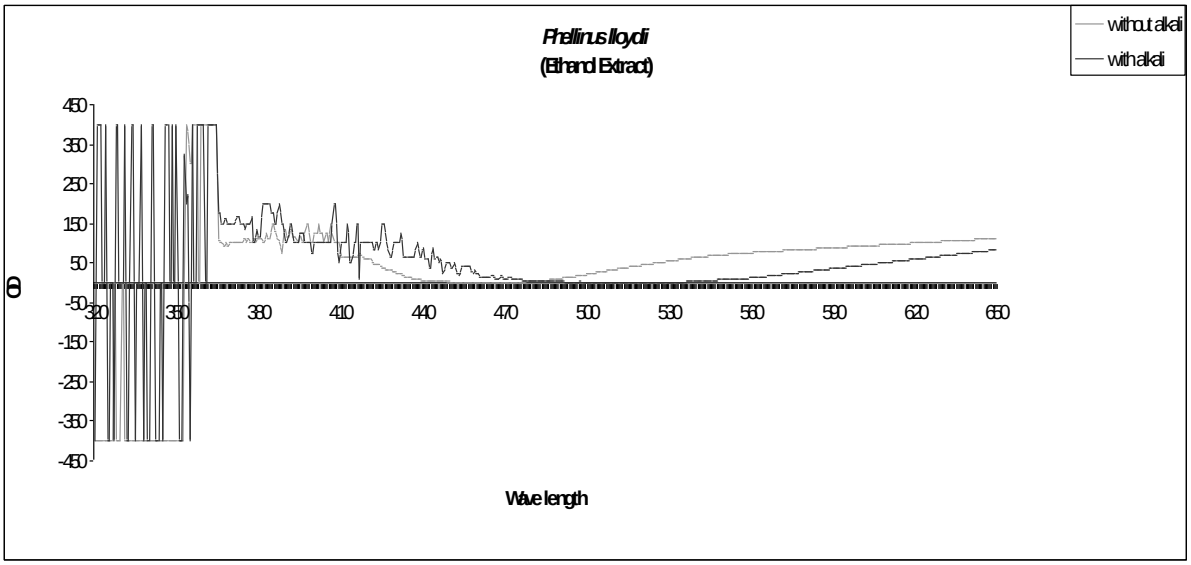


Fig. 8: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. linteus*





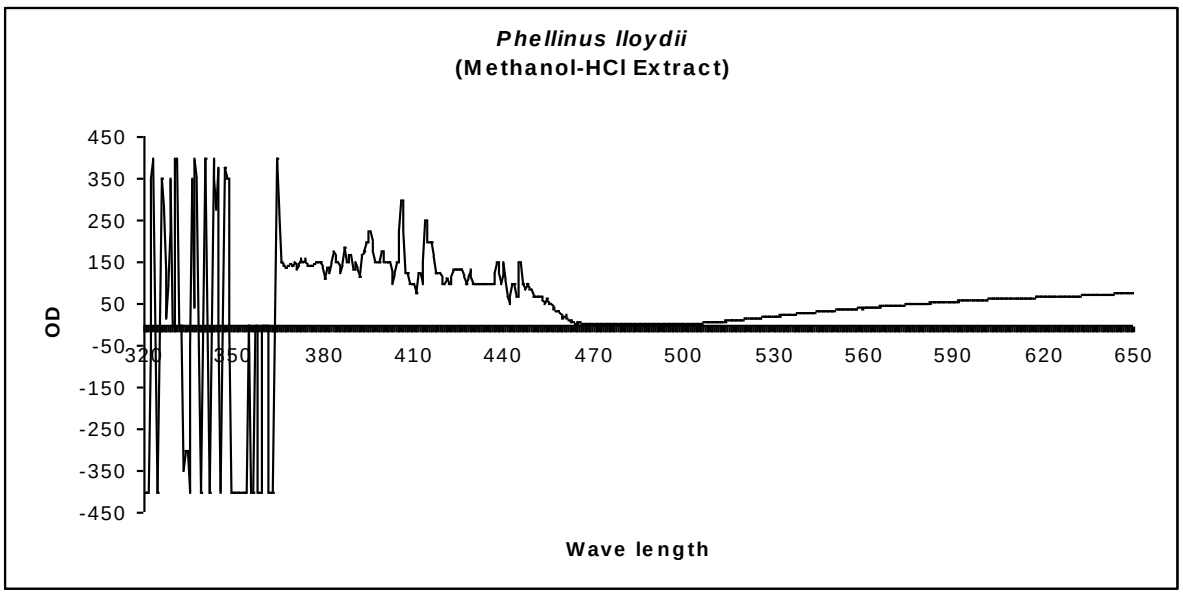


Fig. 9: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. lloydii*

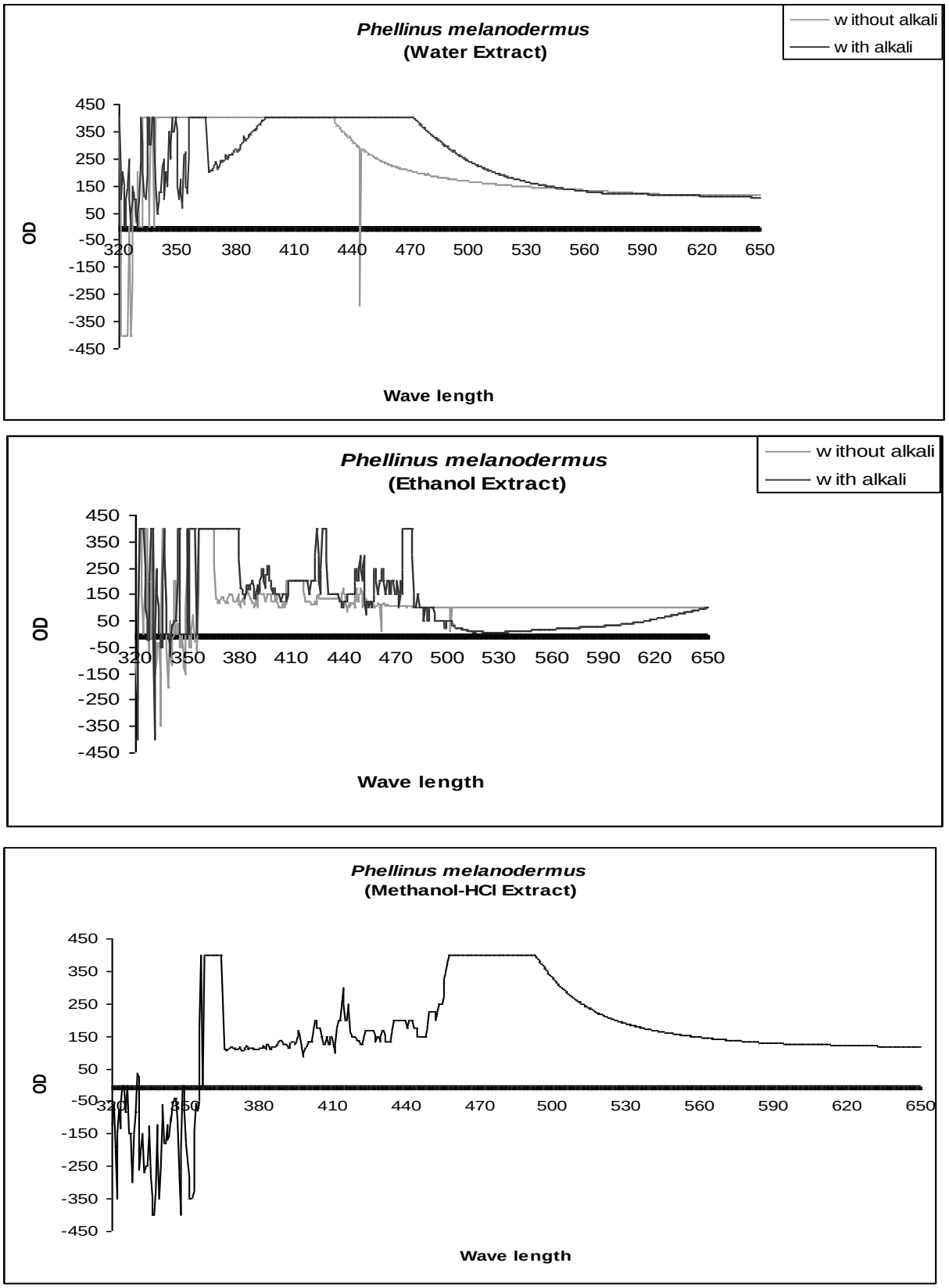


Fig. 10: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. melanodermus*

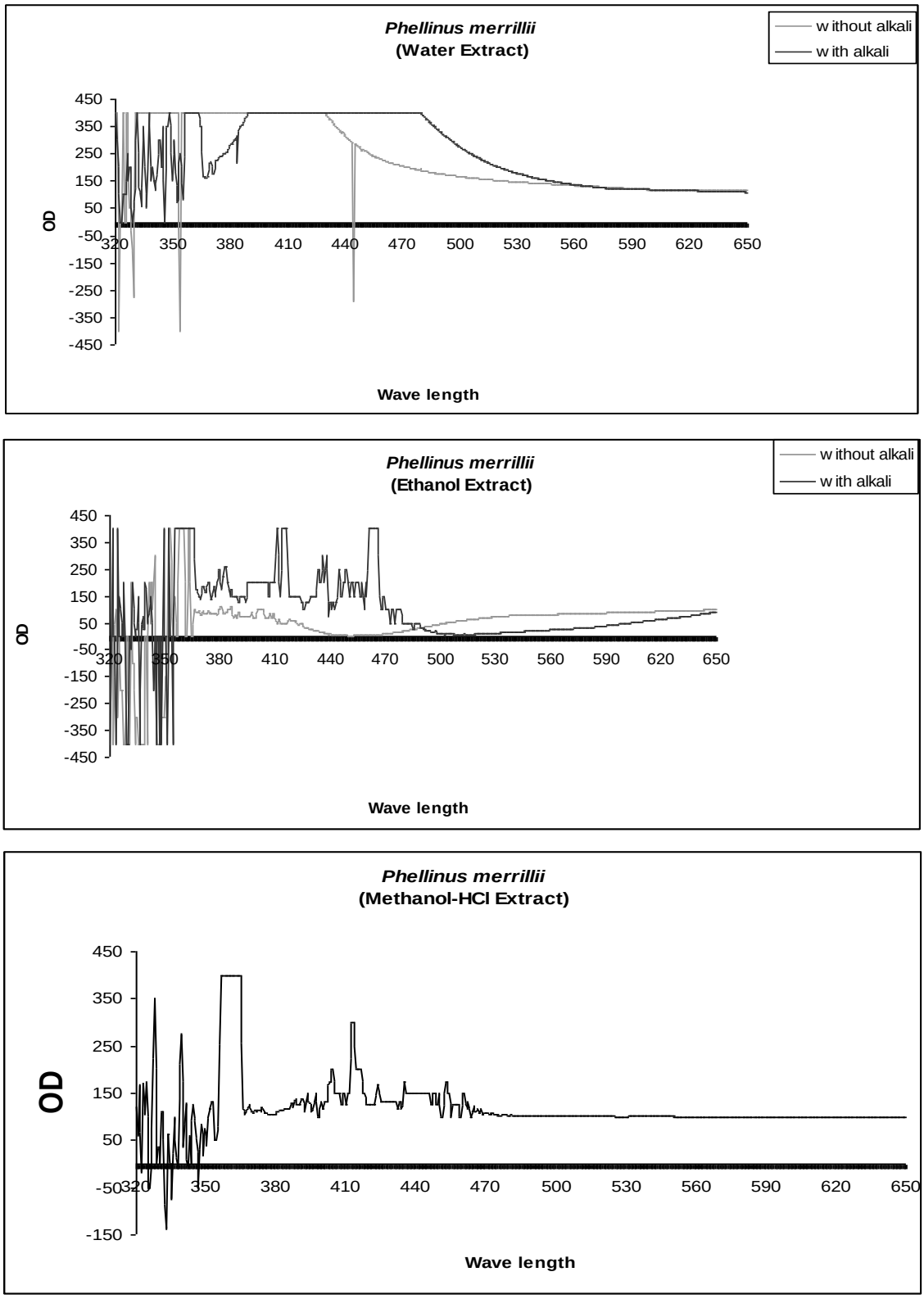


Fig. 11: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol-HCl extract of *Ph. merrillii*

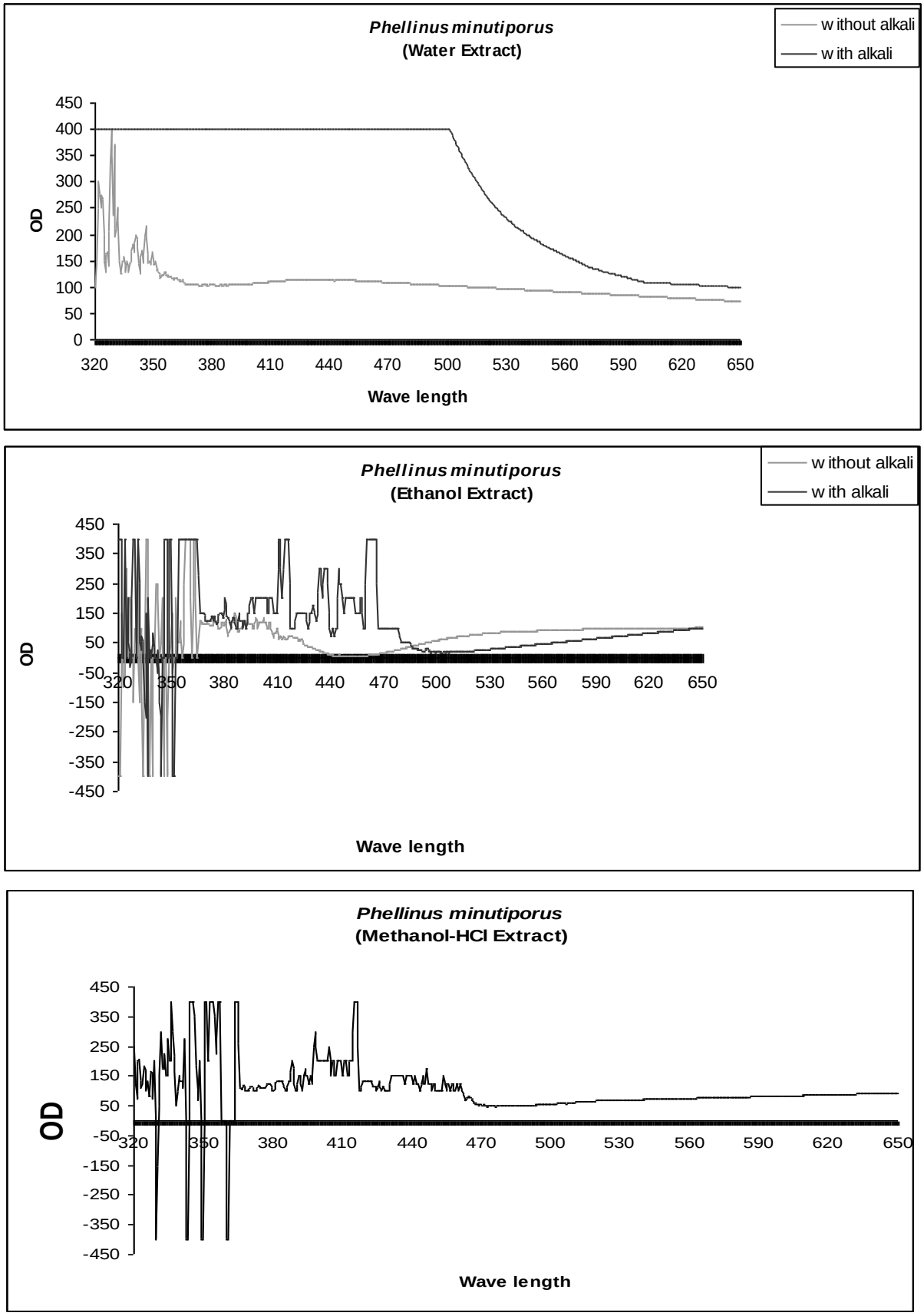
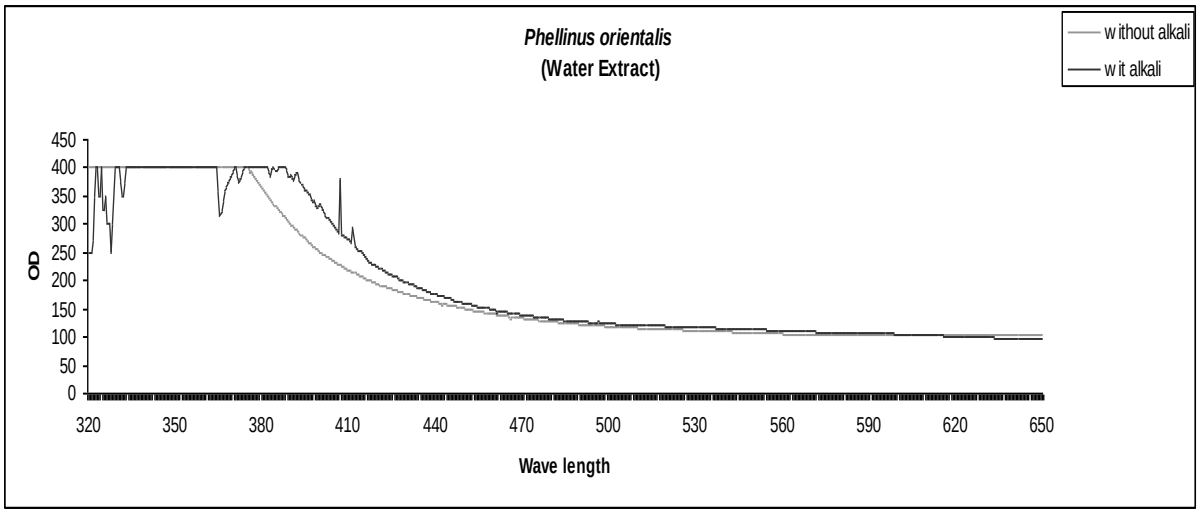
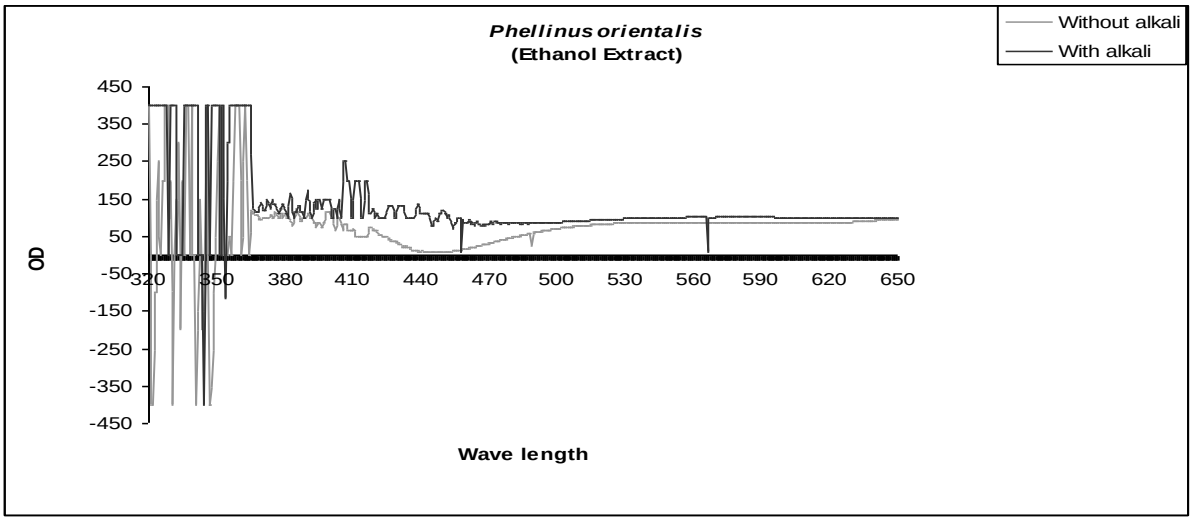


Fig. 12: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. minutiporus*





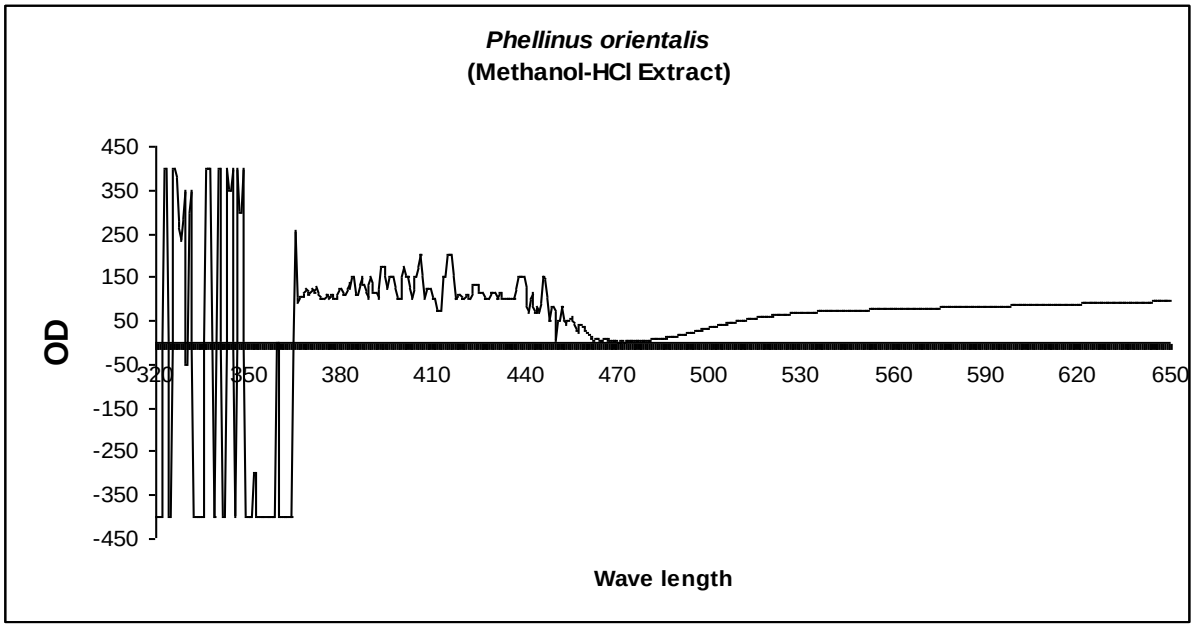
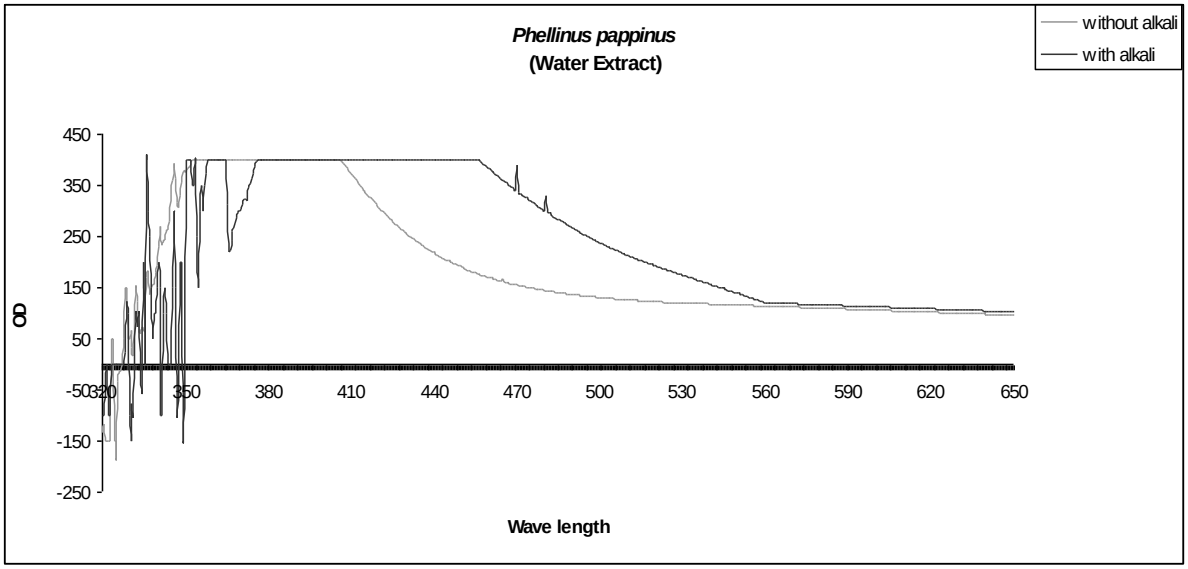
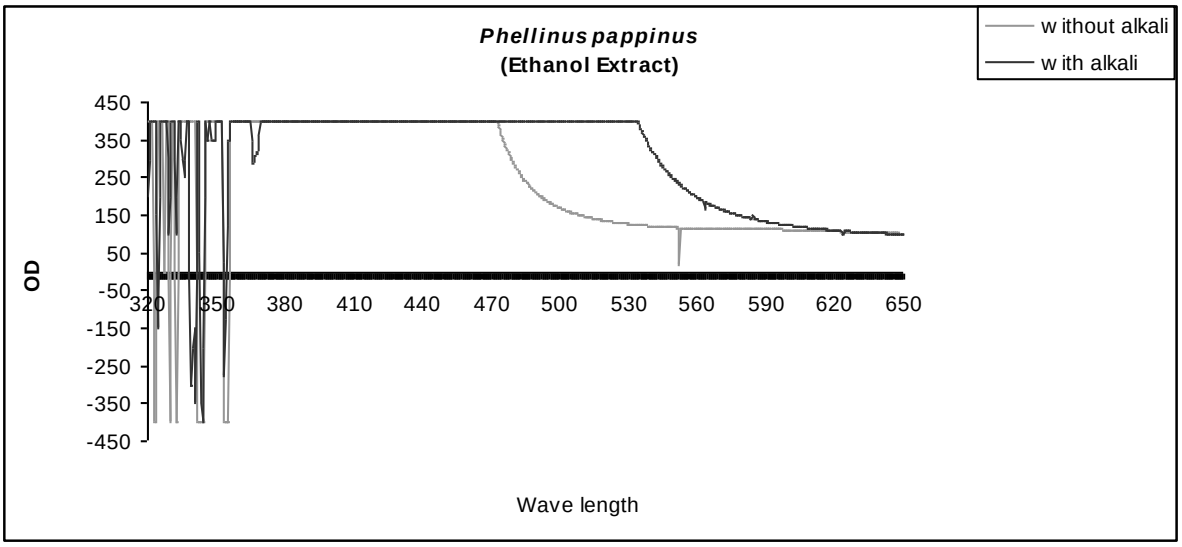


Fig. 13: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. orientalis*





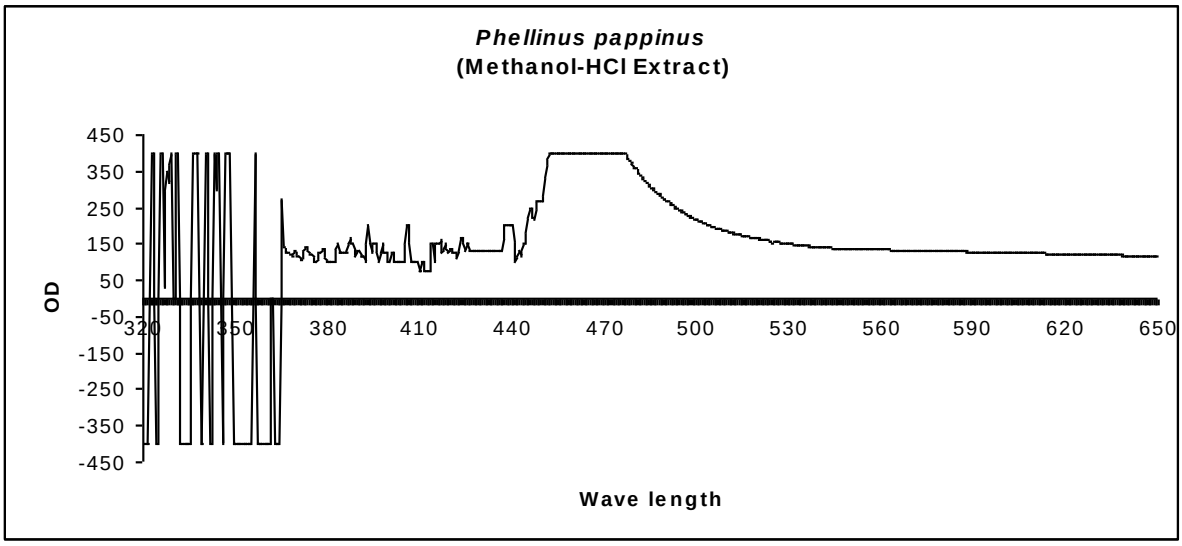


Fig. 14: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol-HCl extract of *Ph. pappianus*

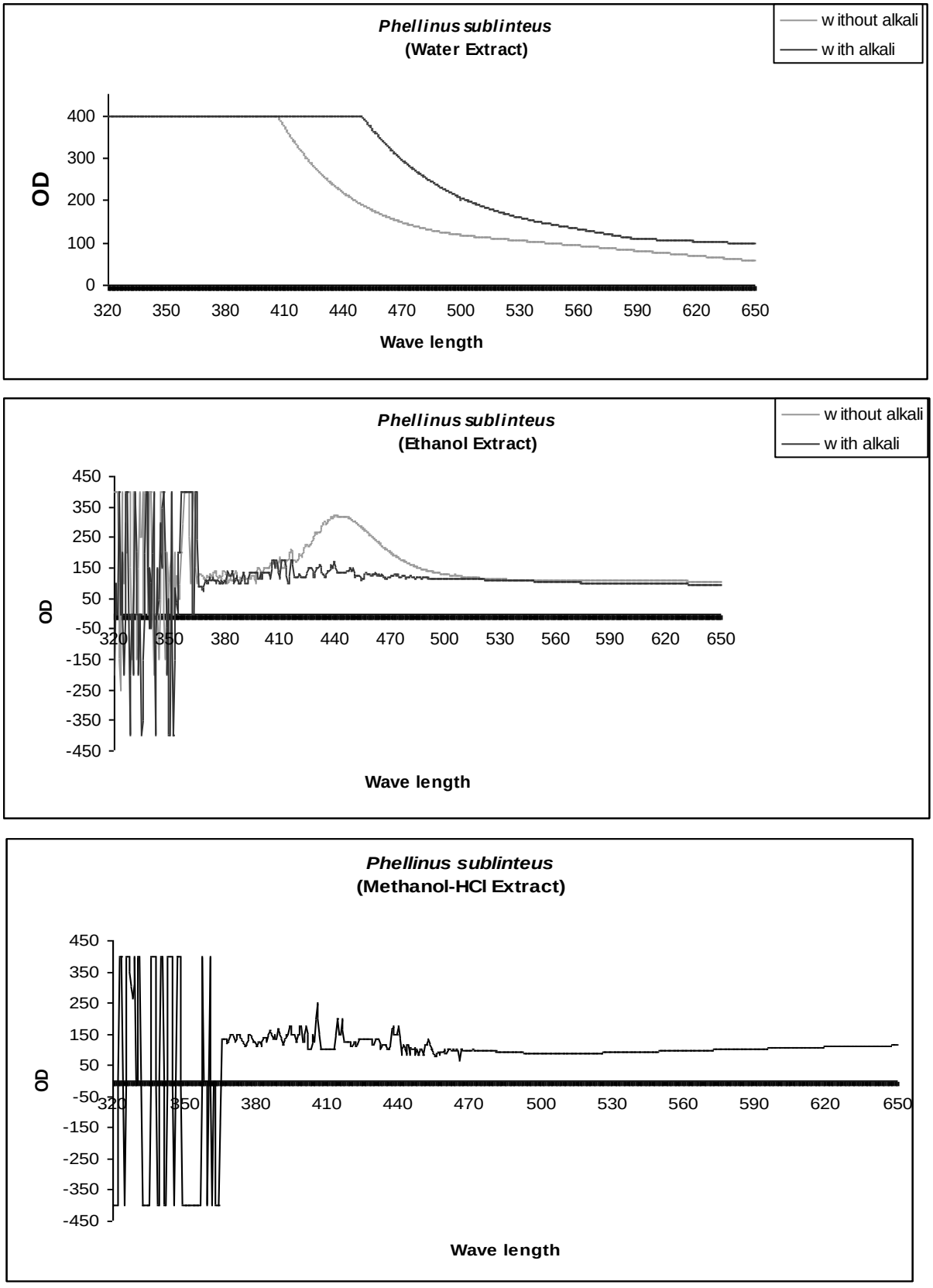


Fig. 15: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. sublinteus (= Inonotus luteoumbrinus)*

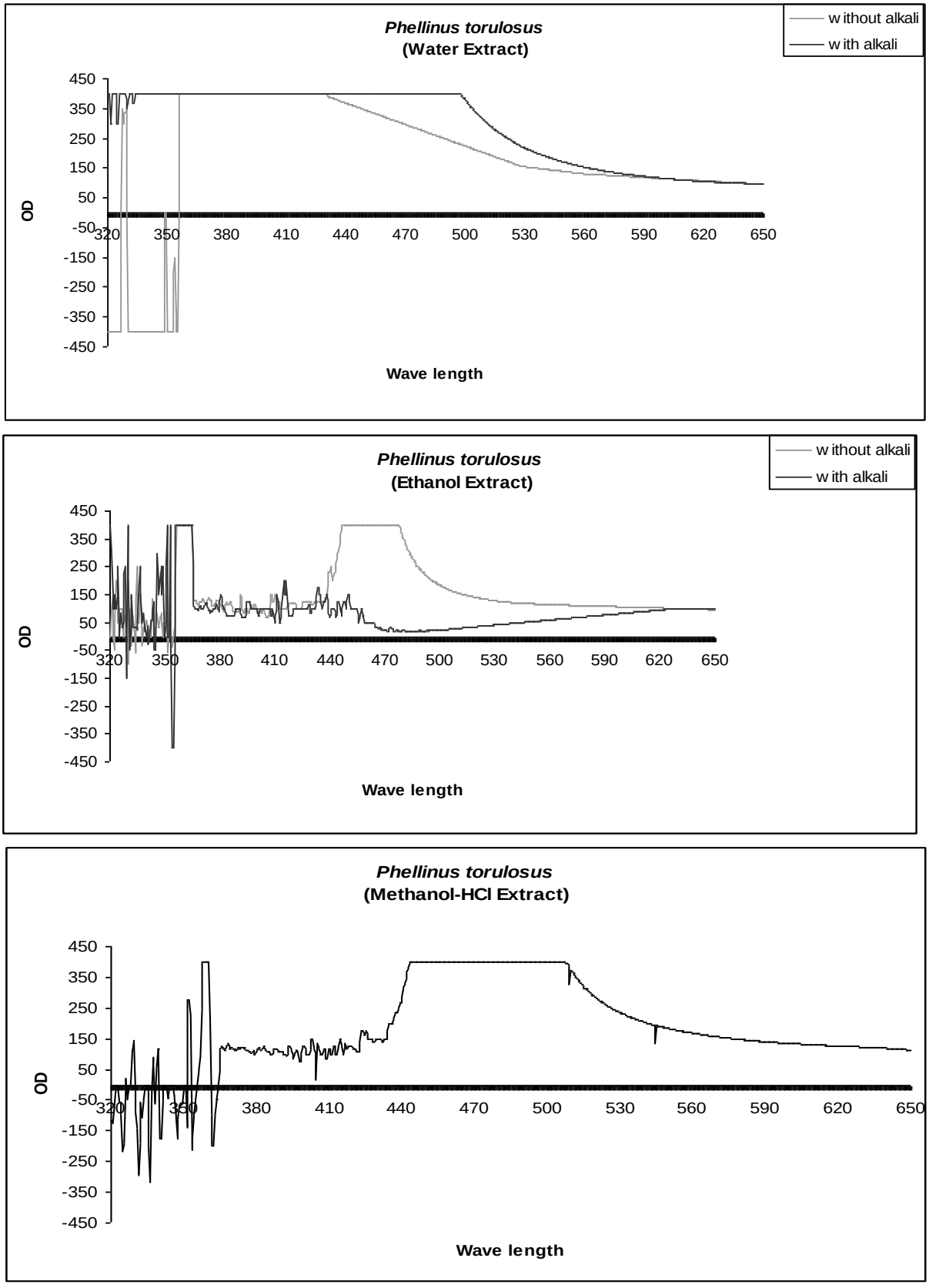


Fig. 16: Absorption spectra of alkalized and non-alkalized water, ethanol and methanol–HCl extract of *Ph. torulosus*

Absorption spectra of aqueous extracts:

In most of the study samples, the spectra of aqueous extract were more or less similar and unspecific. The curves were without any maxima or minima however, *Ph. badius*, *Ph. lloydii*, *Ph. orientalis* and *Ph. fastuosus* showed intense absorption in the region of 330–350 nm. Whereas, *Ph. pappianus*, *Ph. sublinteus* (= *Inonotus luteoumbrinus*), *Ph. adamantinus*, *Ph. minutiporus*, *Ph. merrillii*, *Ph. melanodermus*, *Ph. linteus*, *Ph. crocatus*, *Ph. torulosus*, *Ph. coffeatoporus*, *Ph. aureobrunneus*, *Ph. griseoporus* showed absorption up to 500 nm with horizontal absorption plateau and ending already in the region of 500–600 nm. The curves of alkalized aqueous extracts were almost similar to those of unalkalized extracts, but exhibiting enhanced absorption.

Absorption spectra of ethanol extracts:

Based on the absorption spectra of ethanolic extract of basidiocarp, three groups can be observed. First group comprised of seven species: *Ph. badius*, *Ph. lloydii*, *Ph. orientalis*, *Ph. sublinteus (= Inonotus luteoumbrinus)*, *Ph. adamantinus*, *Ph. torulosus* and *Ph. coffeatoporus*. These species showed intensive absorption in the region of 330–350 (–370) nm. The second group comprised of six species: *Ph. minutiporus*, *Ph. merrillii*, *Ph. melanodermus*, *Ph. linteus*, *Ph. aureobrunneus* and *Ph. griseoporus*. Showing more or less similar curves with an intense absorption at 330–350 nm and 410–470 nm. Later decreasing up to 500 nm and showed gradual surge up to 650 nm. The curves of alkalized and unalkalized extracts were more or less similar. However, alkalized extract had enhanced absorption. In case of unalkalized extract, the curves of *Ph. badius* and *Ph. merrillii* came to end at 440 nm and then after increased slightly and gradually and finally ended at 650 nm. While rest of the species in this group showed decrease in the curve at the region of 470–500 nm and the curves remained rather straight and steady up to 650 nm. Whereas, the third group comprised of three species: *Ph. pappianus*, *Ph. fastuosus* and *Ph. crocatus*. These species had absorption in two regions, 330–350 nm and 355–530 nm. The curves showed gradual decrease up to 590 nm and remained linear up to 650 nm. Moreover, the curves of *Ph. fastuosus* and *Ph. crocatus* were more or less similar and showed sudden decrease at 590 nm but later increased steadily up to 650 nm. The curves in these three groups did not show any specific maxima or minima.

Absorption spectra of methanol–HCl extracts:

In the case of methanol-HCl extract certain specificity was observed and five groups could be separated on the basis of absorption pattern.

The first group comprised of *Ph. adamantinus*, *Ph. badius*, *Ph. lloydii*, *Ph. minutiporus*, *Ph. orientalis* and *Ph. sublinteus* (= *Inonotus luteoumbrinus*) initially showing intense absorption in the region of 330–350 nm (- 360) and later falling nonspecifically. However, *Ph. lloydii*, *Ph. minutiporus*, and *Ph. orientalis* showed falling of the curve at 470 nm and later on increased gradually up to 650 nm. While, other species of this group did not show such falling and remained rather linear up to 650 nm. The second group comprised only of two species, *Ph. aureobrunneus* and *Ph. coffeatoporus*. These two species showed intense absorption in the region of 350–360 nm. The curve remained steady up to 650 nm. The third group also comprised of two species: *Ph. linteus* and *Ph. merrillii*. These species showed more or less similar absorption curves without any maxima or minima and intense absorption in the region of 350–370 (–375) nm. In case of *Ph. linteus* the curve showed slightly decrease in the region of 470–530 nm but then after the curve showed slow and gradual increasing and remained steady up to 650 nm. Such decrease was not observed in *Ph. merrillii*.

Whereas, fourth group comprised of five species: *Ph. crocatus*, *Ph. fastuosus*, *Ph. melanodermus*, *Ph. pappianus* and *Ph. torulosus*. An intensive absorption in the region of 330–370 nm. was observed in case of *Ph. fastuosus* and *Ph. pappianus* while other species showed absorption in the region of 350–370 nm. Except *Ph. fastuosus*, remaining species also showed absorption in the region of 440–500 (–510) nm with gradual falling in the curve up to 590 nm and becoming linear up to 650 nm. Similarly, a horizontal absorption plateau was observed in the region of 440–500 (–510) nm in these species except *Ph. fastuosus*. Lastly, the fifth group comprised only one species, *Ph. griseoporus*. This species showed initial intense absorption in the region of 330–340 nm and later decreasing sharply and suddenly at 440 nm but the curve later resumed linearity up to 650 nm. All the species of these five groups did not have any absorption maxima or minima.

Determination of extinctions (E) and xanthochroic coefficient (*x*) of *Phellinus* spp.:

Both aqueous and ethanol extracts of the study specimen were xanthochroic (table 2). Moreover, at all the wavelengths, the extinction of an alkalized extract was higher than that of unalkalized extract (see Figs 1–16).

Table 2: Extinctions (E) and xanthochroic coefficient (*x*) of *Phellinus* spp.

Species of Phellinus *with sample code*	**Aqueous extract**				**Ethanol extract**			
	350 nm		450 nm		350 nm		450 nm	
	E	*x*	E	*x*	E	*x*	E	*x*
Phellinus adamantinus (PH – 5A)	0.20	5.01	0.87	1.15	2.33	0.43	0.31	3.18
Phellinus aureobrunneus (PH – 4)	1.14	0.88	0.86	1.17	0.13	8.00	2.00	0.50
Phellinus badius (PH – 12)	0.30	3.37	1.02	0.98	1.00	1.00	0.92	1.08
Phellinus coffeatoporus (PH – 13)	1.00	1.00	0.86	1.17	0.30	3.33	4.00	0.25
Phellinus crocatus (PH – 7)	0.00	0.00	0.86	1.17	1.00	1.00	1.00	1.00
Phellinus fastuosus (Adali – 20)	1.14	0.88	1.05	0.95	1.00	1.00	0.93	1.07
Phellinus griseoporus (PH – 5)	1.14	0.88	0.86	1.17	0.13	8.00	2.00	0.50
Phellinus linteus (PH – 18)	1.00	1.00	1.00	1.00	0.19	5.33	0.73	1.37
Phellinus lloydii (PH – 9)	0.15	6.88	1.1	0.9	1.00	1.00	0.05	21.74
Phellinus melanodermus (PH – 38)	2.67	0.38	0.65	1.53	0.50	2.00	0.75	1.33
Phellinus merrillii (Adali – 21)	1.60	0.63	0.65	1.53	1.00	1.00	0.02	57.69
Phellinus minutiporus (PH – 31)	0.36	2.80	0.28	3.53	0.13	8.00	0.02	41.67
Phellinus orientalis (PH – 1)	1.00	1.00	0.94	1.06	0.63	1.60	0.08	12.94
Phellinus pappianus (PH – 22)	0.94	1.06	0.48	2.10	1.00	1.00	1.00	1.00
Phellinus sublinteus (PH - 19) (=*Inonotus luteoumbrinus*)	1.00	1.00	0.48	2.09	0.50	2.00	2.30	0.43
Phellinus torulosus (PH – 27)	1.00	1.00	0.86	1.17	1.00	1.00	2.67	0.38

The extinction E, which reflects the darkness and the amount of the soluble pigment in the extract varied in different species and even in sample of same species. Further, pigment soluble in water and ethanol seems different in some species. Overall, the aqueous extract was light in colour as compared to ethanolic extract. The reaction (see *x* in the table 1) was observed to be slightly weak in case of water extracts of *Ph. badius* and *Ph. lloydii* and ethanolic extract of *Ph. aureobrunneus, Ph. coffeatoporus* and *Ph. griseoporus.* On the other hand, *Ph. lloydii* showed intense xanthochroic reaction in ethanolic extract, while *Ph. merrillii, Ph. minutiporus* and *Ph. orientalis* showed intense reaction in both aqueous and ethanol extracts. The degree of darkening of the ethanol extract was different than that of aqueous extract.

The phenol contents in the water, ethanol and methanol-HCl extracts are represented in table 3. The amount of phenol contents were more in both ethanol and methanol–HCl extract (table 2) except PH-7, PH-12 and PH-19, ethanol extract of PH-22 and methanol extract of PH-27.

Table 3: Phenol contents (mg $100g^{-1}$) in water, ethanol and methanol–HCl extracts of different *Phellinus* spp.

Sample Code	WATER	ETHANOL	METHANOL : HCL
PH-12	5.97 ± 0.02*	7.38 ± 0.07	9.15 ± 0.06
PH-9	6.47 ± 0.02	24.51 ± 0.03	13.59 ± 0.02
PH-1	4.77 ± 0.01	19.33 ± 0.06	10.10 ± 0.06
PH-22	2.90 ± 0.02	6.32 ± 0.03	14.38 ± 0.10
PH-19	3.68 ± 0.04	8.54 ± 0.03	6.87 ± 0.05
PH-5A	3.56 ± 0.04	13.29 ± 0.00	14.88 ± 0.71
PH-31	4.61 ± 0.01	20.72 ± 0.01	15.12 ± 0.03
A-20	7.64 ± 0.02	19.94 ± 0.17	26.41 ± 0.07
A-21	6.39 ± 0.07	16.90 ± 0.03	24.60 ± 0.00
PH-38	6.07 ± 0.03	22.24 ± 0.01	12.18 ± 0.01
PH-18	3.73 ± 0.10	21.39 ± 0.01	14.52 ± 0.07
PH-7	4.46 ± 0.04	9.05 ± 0.04	9.21 ± 0.00
PH-27	4.28 ± 0.03	15.39 ± 0.02	8.73 ± 0.03
PH-13	3.73 ± 0.11	18.68 ± 0.01	16.95 ± 0.02
PH-4	3.89 ± 0.03	19.44 ± 0.03	18.55 ± 0.69
PH-5	4.76 ± 0.01	12.37 ± 0.02	14.88 0.05

*Mean± SD

It is revealed from the absorption spectra that the species of group 1–4, i.e. *Ph. adamantinus, Ph. badius, Ph. lloydii, Ph. minutiporus, Ph. orientalis, Ph. sublinteus (= Inonotus luteoumbrinus), Ph. aureobrunneus, Ph. coffeatoporus, Ph. linteus, Ph. merrillii, Ph. crocatus, Ph. fastuosus, Ph. melanodermus, Ph. pappinus* and *Ph. torulosus* showed absorption in the range of 330 to 350 nm. Such absorption may be due to presence of compounds related to hispidin (Parmasto and Parmasto, 1979). In addition, these species also showed absorption up to 360 to 375 nm which could be because of the analogue of hispidin. That is chemically these pigments may belong to styrylpyrones (Fiasson 1982; Lee and Yun 2011)**.** However, *Ph. griseoporus* showed absorption only in the region of 330–340 nm, therefore, this compound may belong to some other class of the pigments or could be some other analogue of hispidin.

IV. Discussion:

Fiasson (1977, 1982) detected presence of hispidin in several *Phellinus* species including *Ph. conchatus* and *Ph. torulosus.* Thus, this supports the spectrophotometric data obtained in this study. Furthermore, it is mentioned that the styrylpyrones are strictly restricted to family Hymenochaetaceae (Fiasson 1982) and has some medicinal properties (Kyoung and Yun 2011). It is could be concluded that the pigments in the studied *Phellinus* samples may be related to hispidin or the analogues of it (Fiasson 1982).

Besides taxonomic importance, yet another significance of this study is application in natural dye industry. Several dyes have been isolated from number of aphyllophoralean taxa, including *Phellinus* species. Dye with shades of gray, green and orange were obtained from *Ph. gilvus* and were used to dye the wool, mordanted or not (Cedano et al. 2001). These natural dyes can also be used in food industry and unfortunately; no Indian species have been explored for such purpose. Similarly, a much comprehensive account of medicinal properties of styrylpyrone in *Inonotus* and *Phellinus* is summarized in table 4 (Kyoung and Yun 2011).

Table 4: Styrylpyrone(s) identified from various medicinal mushrooms including *Inonotus, Phellinus* species (Kyoung and Yun, 2011).

Name of the fungus	Styrylpyrone(s) identified	Bioactivity
Inonotus hispidus (Bull.) P. Karst.	3,14'-Bihispidinyl, Fasciculin A, Fasciculin B, Hispidin, Hypholomine B	Anti-oxidant, cytotoxic, anti-inflammatory, anti-viral, anti-dementia, anti-diabetes, anti-platelet aggregation
Inonotus obliquus (Pers. ex Fr.) Pilat	Inonoblin B, Inonoblin C, Phelligridin D=Meshinokobnol B, Phelligridin E, Phelligridin G, Phelligridin I=Inonoblin A	
Inonotus xeranticus (Berk.) Imazeki & Aoshima	1,1-distyrylpyrylethan=Pinillidin, 3,14'-Bihispidinyl, Davallialactone, Fasciculin A, Fasciculin B, Hispidin, Hypholomine B, Inoscavin A, Inoscavin B, Inoscavin C, Inoscavin D, Inoscavin E=Phellifuropyranone A, Interfungin A, Interfungin B, Interfungin C, Methyldavallialactone, Methylinoscavin A, Methylinoscavin B, Methylinoscavin C, Methylinoscavin D, Phelligridin D=Meshinokobnol B, Phelligridin F	
Inonotus sp.	Isohispidin	
Phellinus baumii Pilat	Davallialactone, Hispidin, Interfungin A, Phelligridin D=Meshinokobnol B	
Phellinus igniarius (L.:Fr.) Quél.	3,14'-Bihispidinyl, Davallialactone, Hispidin, Inoscavin A, Phelligridimer A, Phelligridin A, Phelligridin B, Phelligridin C=Meshinokobnol A, Phelligridin D=Meshinokobnol B, Phelligridin E, Phelligridin F, Phelligridin G, Phelligridin H, Phelligridin I=Inonoblin A, Phelligridin J	
Phelllinus linteus (Berkeley & M. A. Curtis) Teng	1,1-distyrylpyrylethan=Pinillidin, 3,14'-Bihispidinyl, Fasciculin A, Fasciculin B, Hispidin, Hypholomine B, Inoscavin A, Inoscavin E=Phellifuropyranone A, Interfungin A, Phelligridin C=Meshinokobnol A, Phelligridin D=Meshinokobnol B, Phellinusfuran A, Phellinusfuran B	
Phellinus pini (Brot.) Murrill	1,1-distyrylpyrylethan=Pinillidin, Hispidin	
Phellinus ribis (Schumach.) P.Karst.	Fasciculin A, Fasciculin B, Hispidin, Hypholomine B	
Gymnopilus aeruginosus (Peck) Singer	Bisnoryangonin	
Hypholoma elongatipes (Peck) A.H.Sm.	Fasciculin A, Fasciculin B, Hypholomine A, Hypholomine B	
Pholiota alnicola (Fr.) Singer	Fasciculin A, Fasciculin B, Hypholomine A, Hypholomine B	

Pholiota squarrosa Kumm.	Squarrosidine	

V. Conclusions:

Colour of the context is considered as an important taxonomic character besides conventional characters such as presence of setae and clampless hyphae. A 'semi-chemical' approach of xanthochroic reaction was followed. This xanthochroic reaction is mainly due to presence of styrylpyrones that are strictly restricted to Hymenochaetaceae family. Two mutually exclusive styrylpyrones – hymenoquinone and a dimer of hispidin are found in Hymenochaetaceae. Whereas, hispidine and its two dimer hypholomin B and 3,14'-bishyspidinyl are mainly found in *Phellinus*. It appears that the nature and distribution of styrylpyrons from other species of *Phellinus* should yield more natural taxonomy not only of Hymenochaetacae but also one of the large genus *Phellinus*.

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