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LUMINESCENT COMPOUNDS: GINGEROL, QUININE SULPHATE AND FLUORESCEIN, A SHORT REVIEW

COMPUESTOS LUMINISCENTES: GINGEROL, SULFATO DE QUININA Y FLUORESCEINA, REVISIÓN ABREVIADA

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ABSTRACT

Certain compounds have luminescent properties. When they are submitted to ultraviolet radiation in a certain wavelength range, electrons get excited passing thus from a fundamental energy state to a higher one. When electrons return to their basic state, they emit the excess energy under the form of radiation in the visible spectrum (390 to 750 nm). We have isolated from their natural sources or synthesized three compounds of such kind, namely gingerol, quinine sulphate and fluorescein, and we have established their yields and observed their luminescent properties. A brief bibliography is provided.

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RESUMEN

Ciertos compuestos tienen propiedades luminiscentes. Cuando se someten a la radiación ultravioleta en un cierto rango de longitud de onda, los electrones se excitan pasando de un estado de energía fundamental a uno superior.

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Cuando los electrones vuelven a su estado básico, emiten el exceso de energía bajo la forma de radiación en el espectro visible (390 a 750 nm). Hemos aislado tres compuestos de este tipo, a saber, gingerol, sulfato de quinina y fluoresceína a partir de sus fuentes naturales o sintetizado, y hemos establecido sus rendimientos y observado sus propiedades luminiscentes. Una breve historia bibliográfica es ofrecida.

LUMINESCENT COMPOUNDS: GINGEROL, QUININE SULPHATE AND FLUORESCEIN, A SHORT REVIEW

Luminescence is a term first employed in 1888 by Q.C. Lum [1] and makes reference to light emission from certain substances with no rapport to heat. It is also called cold-body radiation. Common causes are chemical reactions but also electrical energy or stress on a crystal. Luminescence is a spontaneous energy emission. Let us signal that light emissions due to heating of substances is called as incandescence.

The types of luminescence are currently recognized as: chemiluminescence [2-5], due to a chemical reaction, the following luminescence phenomena are due to chemical reactions: bioluminescence, a kind of chemiluminiscence or light produced by a biochemical reaction having place in a living organism. This natural phenomenon is observed in some insects and in certain marine organisms and fishes [6-33]; electroluminiscence, or luminescence derived from an electrochemical reaction [34-43]; lyoluminescence, produced when dissolving an irradiated solid into a liquid [44]; candoluminiscence or incandescence, light emitted after heating a body [45,46]; besides chemiluminiscence there are other kinds of luminescence phenomenon like crystalloluminiscence which is produced during crystallization [47]; electroluminescence, an electrical and optical phenomenon that occurs when a material is submitted to an electric current and as consequence emits energy in the visible spectrum [48], a kind of electroluminescence is cathodoluminescence wich is the emission on photons in the visible spectrum is caused by the impact of electrons on a luminescent material like phosphor [49-54].

As a result of the action over a solid we obtain the mechanoluminescence, if a solid is rubbed or scratched, or crushed, this bonds rupture provokes luminescence called as triboluminescence [55-64]; fractoluminescence happens when bonds rupture occurs by fractures in a crystal [65-72]; another mechanoluminescence is piezoluminescence appearing as an emission due to pressure applied over certain solids [73,74]. When sound is applied to liquid an implosion of bubbles occurring produces luminescence [75-78]. Photoluminescence [79-89] is the result of absorbing photons and they are classified in fluorescence [90-109], phosphorescence [110] and Raman emission [111-115]. When some materials are subjected to bombardment by using radiation like for instance alpha particles, beta particles, or gamma rays we are in the presence of the phenomenon called radioluminescence [116]. Certain metals under a crystal form like minerals for example, when submitted to ionizing radiation or electromagnetic radiation and after heating, they emit light called thermoluminescence [117]. Cryoluminescence, is the emission of light when an object is cooled.

Diverse applications of luminescence from varied sources exist. The most important application nowadays widespread is LED or Light Emitting Diode [118]. This is when a semiconductor light source emits light if a current flow through it [119-140]. Also phosphorescence finds innumerable applications [141,142]. Phosphor thermometry is another application consisting in measuring surface temperatures by an optical method that uses phosphor as a light emitter [143-149]. The thermoluminescence method is when a crystal material previously exposed to heating, is dated on the basis of light emitted by the body under survey on the time [150-154]. The tool employed is a thermoluminescent dosimeter [155,156].

Gingerol [(*S*)-5-hydroxy-1-(4-hydroxy-3-methoxyphenyl)-3-decanone] is a natural product characterized as the active principle of ginger (*Zingiber officinale*) and it gives it its spicy flavor and properties. Gingerol is related structurally to capsaicin and piperine, both constituents of black pepper and chili peppers and responsible of their spiciness [157-159]. Among the biological activities described for gingerol, one of them induces hypothermia in rats [160]. In the animal model, gingerol is apparently effective for the rheumatoid arthritis [161]. Gingerol is not toxic under conventional or standard conditions but it possesses anti-tumor qualities and it is effective against lung and blood cancer [162]. Investigations of the properties of gingerol against cell tumors like bowel, breast tissue, ovaries and pancreas tumors, have been published elsewhere [163-166].

Quinine sulfate is a presentation of quinine which together with cinchonamine constitutes the very important group of the cinchona alkaloids [167]. The alkaloids of the quinine subgroup contain a quinoline ring system generated from the same precursor of cinchonamine subgroup [167]. The cinchona alkaloids are present in three botanical families: Rubiaceae, Apocynaceae and Oleaceae [168], where twenty-four cinchona alkaloids of cinchona species have been described and regrouped in four subclasses, quinine, quinidine, cinchonidine and cinchonine [168]. Cinchona alkaloids have been used for the treatment of malaria since centuries ago [168]. Its most important

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antimalarial principle is quinine active against *Plasmodium falciparum* [169]. In spite of its long liveness, quinine is still an antimalarial alternative when resistance to chloroquine manifests and when artesunate is not available [169]. Quinine sulfate is a way for administering quinine. Quinine sulfate is offered in the market in the form of tablets for instance. Its therapeutic indications include the treatment of malaria or malignant tertian fever provoked by *Plasmodium falciparum*, and the treatment and prophylactic action for leg cramps during sleep in aged people [170].

Fluorescein is a synthetic phenolic and it has dye properties. It is used as a fluorescent tracer in many applications. As a fluophore is used in microscopy and applied in forensics and serology. In medicine it's of extensive use in ophthalmology and optometry [171-186].

The luminescent properties of 6-gingerol and derivatives have been employed in many analytical assays due to their luminescent properties as shown extensively in the literature [187-192]. Quinine sulfate fluorescence has been widely studied and applied in analyses of diverse nature [193-201].

Figure 1 shows the luminescent properties of gingerol, obtained by hydroethanol extraction of oleoresins from bulbs of ginger (*Zingiber officinale*) and those of quinine sulfate obtained in an acid-base steps crystallization process, using sulfuric acid and sodium hydroxide to control the pH, and organic solvents, from the stem bark of quina (*Cinchona calisaya*) and those of fluorescein synthesized by condensation of ftalic anhydride and resorcinol.

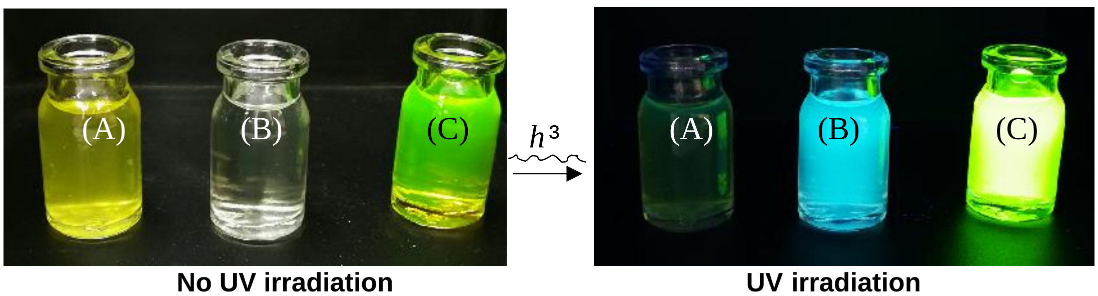

Figure 1. *Luminescent properties of oleoresins of ginger whose major and luminescent constituent is gingerol (A), quinine sulfate (B) and fluorescein obtained in laboratory by condensation of ftalic anhydride and resorcinol (C). UV Irradiation at* ª *350 nm*

EXPERIMENTAL, CONCLUSIONS

Fluorescence is a kind of photoluminescence as a result of emission of light of a different wave-lenght to the UV irradiation applied to the sample. Fluorescein, quinine sulfate and gingerol possess fluorescence properties. Fluorescein is a reddish crystal soluble in ethanol but not in water, it produces an intense greenish fluorescence at pH 8 due to 350 nm irradiation, it has been synthesized in lab by condensation of ftalic anhydride and resorcinol. Quinine is a quinoline-type alkaloid which is extractable from its natural source, the stem-bark of *Cinchona calisaya*, by means of organic solvents and sulfuric acid. The extract is a brownish powder whose purification under alumina percolation afforded cinchona alkaloids. The quinine sulfate purified by crystallization is a white powder which once dissolved in ethanol and irradiated under UV light emits fluorescent light. The bulbs of ginger (*Zingiber officinale*) were ground and dried at 25°C in a special stove with a circulating air system, the plant material was extracted with ethanol 96°, after filtration the ethanol extract showed a brownish color, which after irradiation at 350 nm reflects yellowish fluorescent light attributable to gingerol, its fluorescent principle. The most intense fluorescence was that of fluorescein.

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