Pyridone Disperse Dyes Provide Added-Value

Subjects: Others

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This entry provides a description of some of the disperse dyes based on pyridone and the uses of these disperse dyes as antioxidants and anticancer, as well as the use of polyester fabrics dyed with these dyes in various activities, especially medical activities. It is blamed that the textile industry is one of the major generators of industrial waste due to large quantities of water that contains a variety of pollutants, including dyes. So, our aim in this review is to explain that the dyeing process using high temperature and high pressure method was an environmentally friendly process. Therefore, this review provides a good data for chemists, biologists and interested people working in textile chemistry, public health and environment research areas.

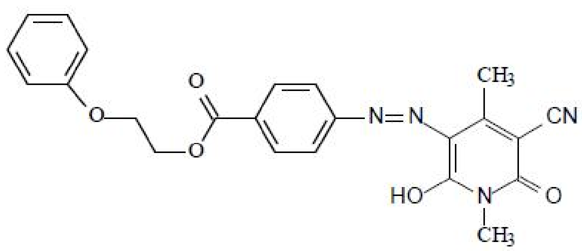
Keywords: pyridone disperse dyes ; ultraviolet protection factor ; azo dyes ; added-value.

1. Introduction

It is known that polyester is widely used in many industries such as textile[1][2][3][4][5][6][7][8][9][10], automotive and packaging. Polyester fabrics have unique advantages in fast drying, dimensional stability, high tensile strength, chemical resistance, and cost effectiveness in textile industry. Polyester fabrics are usually required to be dyed to achieve high added value before marketing. Disperse dyes are mainly used in dyeing and printing processes due to their poor water solubility, bright color, small molecule, and good stability[11][12][13][14][15][16][17]. However, washing is necessary to remove unstable disperse dyes and chemical auxiliaries left after the traditional dyeing or printing processes. Unfortunately, the washing process not only consumes a mass of water but also produces and discharges a large amount of wastewater that contains residual dyes or auxiliaries, which causes in serious environmental problems. Therefore, thinking and applying environmentally sustainable ways to address these problems is highly required[18][19][20][21][22].

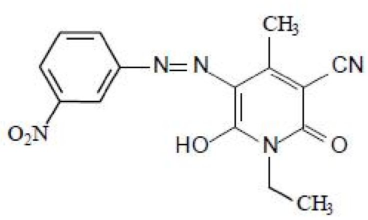
2. Pyridine Disperse Dyes

Aryl azo pyridone dyes are a very important class of dyes. Azo pyridone dyes give bright colors ranging from yellow to orange. Pyridone disperse dyes are utilized in non-textile applications like electronic printing, imaging, laser technology and data storage. It is of value to mention here that pyridone disperse dyes (1,2) are commercially available (Figure 1)[1].



1

Greenish Yellow [88938-37-8]

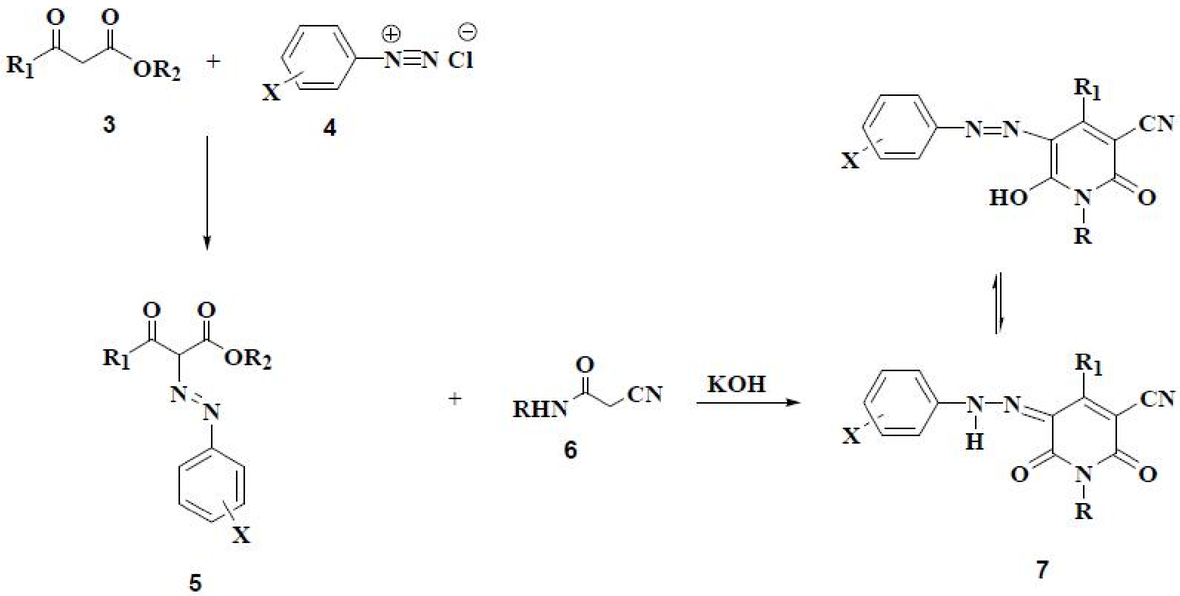


2

Greenish Yellow [37781-00-3]

Figure 1. Some of commercially dyes

The first route for preparing pyridone dispersed dyes 7 is to couple 1,3-dicarbonyl **3** with diazonium salts **4** and then to perform a condensation process with cyanoacetamide **6** (Scheme 1).



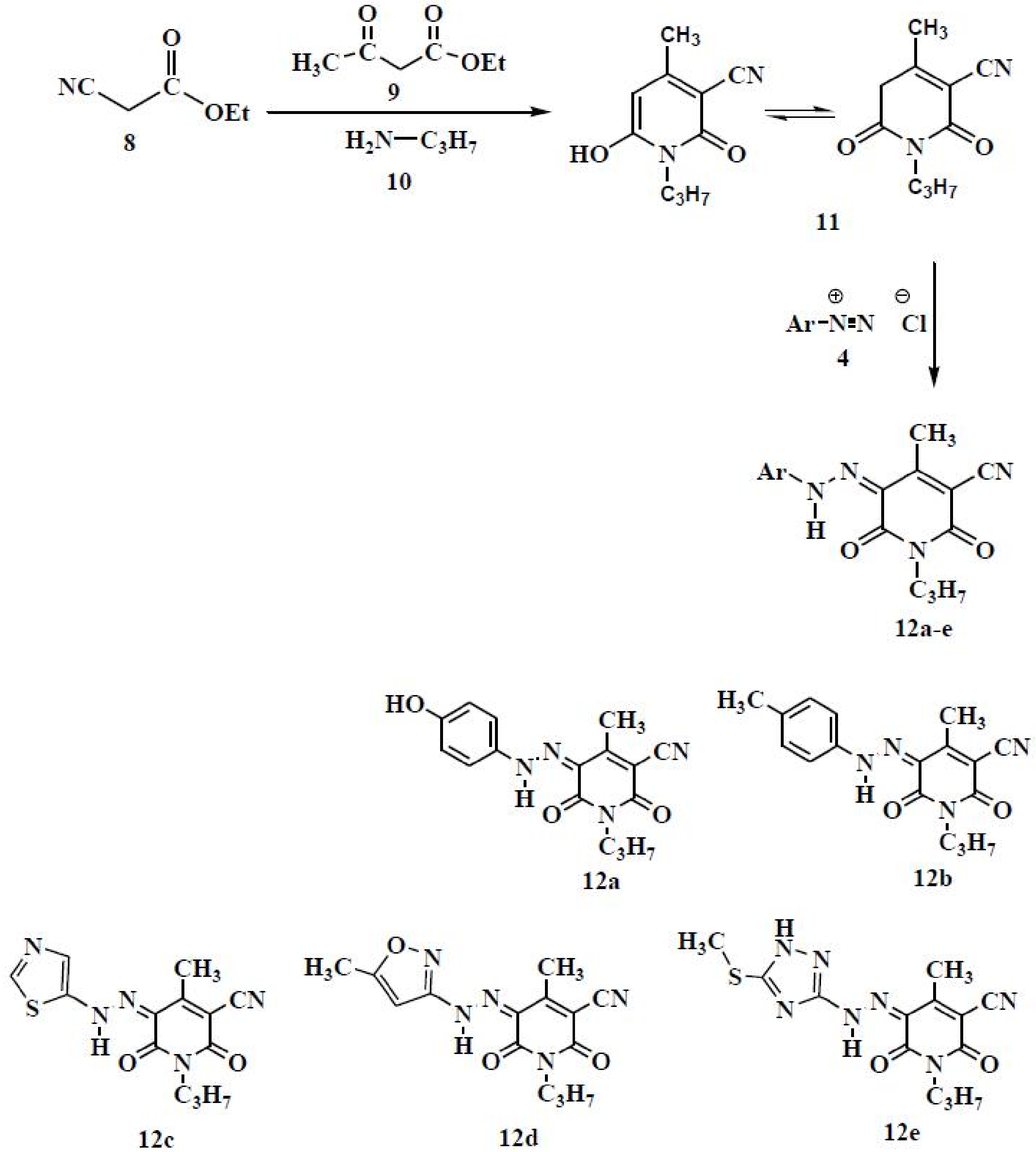
Scheme 1. First route of preparation of known pyridone disperse dyes.

Whereas the widespread and at the same time easiest method that we followed in our previous research to prepare pyridone disperse dyes in an environmentally safe manner was to prepare pyridone and then perform a coupling process with different diazonium salts. El-Apasery *et al.*[23], have created successful combinations of new substituted aryl and heteroarylazoazines as potential antimicrobial colors that were set up from pyridones **11** (Scheme 2).

A very high yield of compound **11** was obtained, when three compounds ethyl cyanoacetate, ethyl acetoacetate, and propyl amine were reacted in absence of organic solvent under reflux for six hours.

This technique gives a satisfactory option to one-pot three components approximations. It additionally streamlines difficult strategies and produce significant favorable products with high yields.

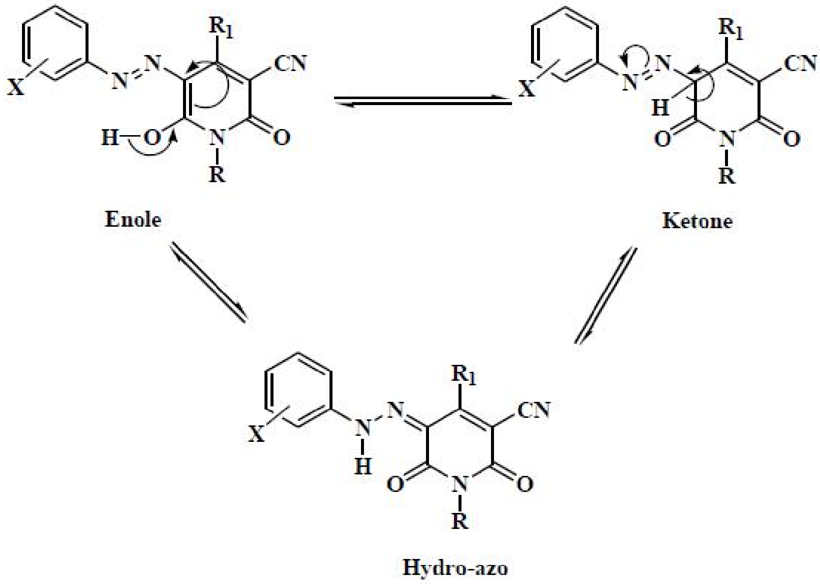
Coupling of compound **11** with aromatic diazonium salts **4** managed comparing tetrahydro-pyridine- carbonitrile s **12a-e** in excellent yields.



Scheme 2. Synthesis of novel biologically active disperse dyes **12a-e**

The functionalized disperse colors **12a-e** were utilized to polyester textures with shade 1% at 130 °C, and a scope of shading conceals was gotten, differing from yellow to light green. The dyeing properties on the polyester textures were assessed as far as their fastness properties. The physical information for the colored fabrics shows that the disperse coloring showed a good washing fastness, likewise the light fastness is fantastic as for the vast majority of the tested compounds except compound **12a** demonstrated great outcome.

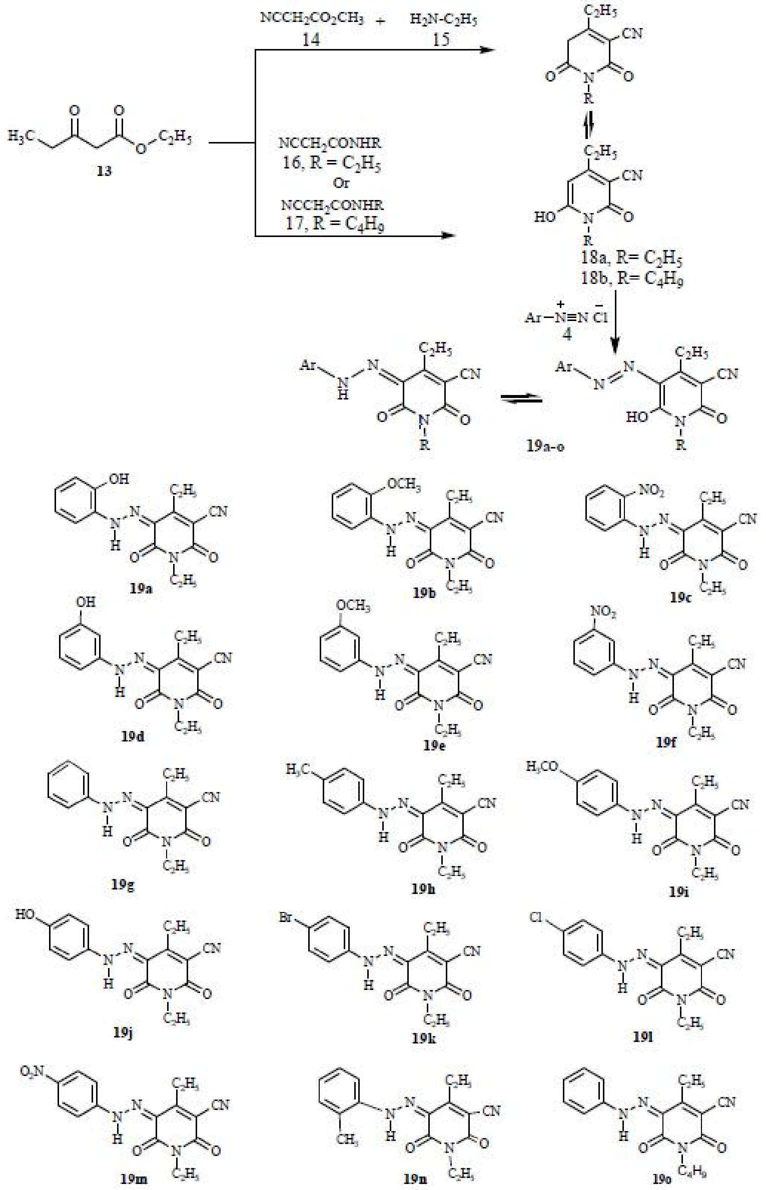
The study of the potential biological activity of these disperse dyes revealed that, dyes **12a** and **12c** possess strong actions, while dyes **12d** and **12e** possess moderate actions against *Staphylococcus auerus* and *Bacillus subtilus* (Gram positive). Hence, pyridone disperse dyes demonstrated capable outcomes for having the possibilities to be used for therapeutic uses. The chance of the presence of an intramolecular hydrogen bond between the hydrazone NH and carbonyl oxygen is additionally ascribed to the stability of the keto-hydrazone structure .



Scheme 3. Enole - Ketone - Hydrazo Tautomerism

As such, El-apasery *et. al.*[24][25] has declared a compelling three part component of methylproipnylacetate **13** , alkyl cyanoacetates **14**, ethyl amines **15**, with more huge yields of **18a** (Scheme 4). Pyridone **18a** could be speedily coupled with heteroaromatic diazonium salts **4** creating the comparing heteroaromatic pyridones scatter colors **19a-f** (Scheme 4) and the exhaustion of these colors was commonly phenomenal on polyester textures with adequate fastness properties (Scheme 4).

Al-Etaibi *et. al*.[26][27][28][29][30] have incorporated pyridone disperse dyes **19g-o**, by means of coupled pyridones **18a** or **18b** with heteroaromatic diazonium salts (Figure 2, 3) and utilized them on polyester textures, to show the effect of substituent on the shade of the combined colors (Scheme 4).



Scheme 4. Novel pyridone disperse dyes.

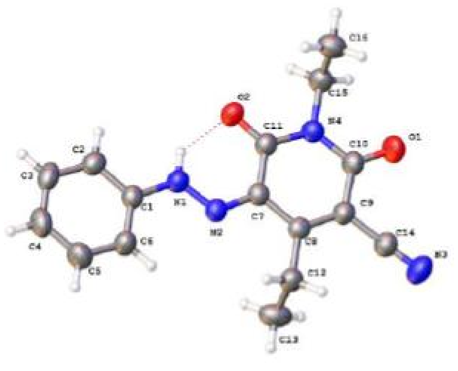


Figure 2. ORTEP of dye **19g**

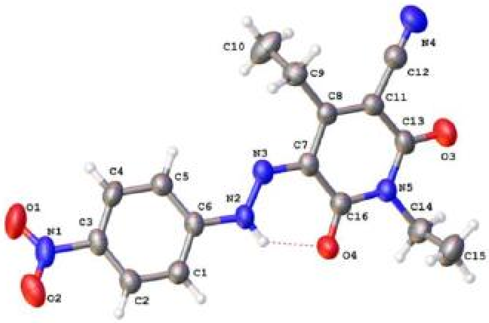


Figure 3. ORTEP of dye **19m**

Compounds **19g-o** were used for coloring polyester surfaces at 130 °C coloring procedure. After the coloring cycle, the colored textures ran in shading from yellow to dull orange. Dyeing performance of polyester textures was assessed as for their fastness properties. The K/S esteems show that these colors have high affinity for polyester textures. The inhibition zone measurement information for the arylhydrazopyridones disperse colors **19g-o** revealed that all tested colors have exhibited intense positive antibacterial activities**.**

3. Cytotoxicity Screening

We reported the anticancer action examination of the fused colors 19n and 19o close by HepG-2, HCT-116, A-549 and MCF-7 cell lines. Different concentrations of disperse dye 19n and disperse dye 19o were used for assessing the IC_{50} µg/mL. Color 19n had strong activity 23.4 (HepG-2), 62.2 (HCT-116), 28 (A-549) and 53.6 (MCF-7) µg/mL, while dye 19o had revealed weak action 196 (HepG-2), 482 (HCT-116), 242 (A-549) and 456 (MCF-7) µg/mL [30].

4. Antioxidant Activities

We assessed the cell antioxidant property of the two disperse colors synthesized by us in a simple and successful manner in vitro by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radicals scavenging activity. The data obtained show that the great antioxidant activity of the disperse color 19n with IC_{50} of 64.5 was more than ascorbic acid as standard with IC_{50} from 14.2, while we portrayed the disperse color 19o as having weak antioxidant activity of IC_{50} 191.6 [30].

5. Dyeing at 130 °C

During our examination, we have considered the nature of scatter colors preserving the environment by decreasing dye residues through polyethylene terephthalate (PET or PETE) textures were hued by colors **19n** & **19o** utilizing the high pressure and temperature coloring methodology. The level of color absorption in dyebaths has been contrasted with the low-temperature coloring method as dyebath squanders straightforwardly and adversely influences nature. The level of absorption of the color by the high temperature (HT) coloring procedure for all polyester textures is totally conflicting with the low temperature coloring measure, and accordingly (HT) extended and developed the shading quality K/S of the colors analyzed and assessed by 309 and 265%. Likewise, it gives us clear evidence that the assessment of the color present in the color streams utilizing (HT) dyeing technique is basically non-existent and insufficient, thusly it is doubtlessly, sullied, and totally sure in nature as these outstanding hues are in the dyebaths is dumped into the earth as waste damages nature [30].

6. The Multifunctional Performance of TiO_2NPs nanoparticles

In an endeavor by us to secure the texture colored by the disperse colors, at that point post-treated polyester textures colored with disperse colors 19n and 19o was set up through a two-step hot cycle after it is totally drenched in an solution of TiO_2 NPs nanoparticles at 80 °C then we perform the curing process at 140°C. At this point, the treated textures are perceived to protect against the impact of ideal UV protection factor running from 34.9 and 283.6 [30]. The treated colored textures with TiO_2 NPs moreover displayed a strong ability to improve the light fastness properties. Moreover, the presumably employments of the treated textures with titanium nanoparticles have been considered, for instance, self-cleaning and anti-fungal behaviors. Strangely, treated polyester colored textures with titanium nanoparticles of scatter color 19n has very good antifungal properties.

7. Conclusions

Pyridone disperse dyes can be efficiently employed to provide added values, we show that the preparation of pyridones derivatives via the interaction of cyanoacetamide and 1,3-dicarbonyl with the first amine or by the reaction of 2-Cyano-N-alkyl-acetamide and 1,3-dicarbonyl in the absence of any organic solvent. Our strategy is simple protocols towards the synthesis of pyridone disperse dyes via a coupling process between pyridones and aryl diazonium salts. New pyridone disperse dyes could be useful as synthetic precursors to azo bonds that may be suitable for electronic and optical applications as non-textile applications. Moreover the post-treated dyed polyester fabrics with titanium oxide nanoparticles exhibit significant antimicrobial activity. Finally, this review discussed the benefits of these pyridone disperse dyes, the ability to use them as antioxidants or to anticancer.

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