with noticeable variations ranging between 1800 and 600 cm^{-1} were normalised and subjected to principal component analysis (PCA) using Minitab 18 software (Minitab Inc., State College, PA). The experimental data were decomposed into a manageable form for the multivariate analysis. The normalised data point was transformed into principal components (PC), and a score plot of the first two PCs was used to generate a score plot to explore the pattern of sample clustering.

Thin layer chromatography

Six strips of respective ink samples applied on white paper were cut into a dimension of 1 mm × 5 mm and placed in separate 1 mL glass tubes. Prior to TLC, an additional solubility test was carried out. In a separate glass tube with ink samples, 100 µL of methanol was added, respectively. Each glass tube was vigorously shaken for 1 minutes and the solubility characteristics of ink samples in methanol were recorded.

For TLC analysis, supernatant methanolic solutions were used for spot application on the TLC plate. Note that only the methanol-soluble ink samples were subjected to TLC. Negative control with the blank white paper of the same dimension was also prepared. Two solvent systems, namely ethyl acetate: ethanol: distilled water (14:7:6) and n-butanol: ethanol: distilled water (4:1:1) were used in this study [8]. TLC plates were heated at 100 ˚C for 1 hour and cooled before spotting with the methanolic ink extracts. Spotted TLC plates were developed in two separate TLC chambers containing different solvent systems. The developed TLC plate was examined under white and ultraviolet lights. R_f values of different visible bands and their respective colours were recorded.

Table 1. Labelling of ballpoint pen and gel pen ink samples

Sample	Types	Brand	Specific Name
BP01	Ballpoint Pen	G'Soft®	BP-GS-56
BP02	Ballpoint Pen	G'Soft®	Ballpoint 5566
BP03	Ballpoint Pen	Pilot	Super-GP
BP04	Ballpoint Pen	Pilot	BP-S
BP05	Ballpoint Pen	Paper Mate®	Fine Blue
BP06	Ballpoint Pen	Paper Mate®	Kilometrico 100
BP07	Ballpoint Pen	Paper Mate®	Kilometrico 80%
BP08	Ballpoint Pen	Faber-Castell	1422
BP09	Ballpoint Pen	Faber-Castell	Speedx 7
BP10	Ballpoint Pen	Stabilo	Excel 828N F
GP01	Gel Pen	Faber-Castell	True Gel
GP02	Gel Pen	Pilot	Super Gel
GP03	Gel Pen	Pilot	Wing Gel
GP04	Gel Pen	Pilot	G-1
GP05	Gel Pen	Carera	Soft-gel S-Fine
GP06	Gel Pen	Carera	V-gel
GP07	Gel Pen	Carera	Soft-gel Fine
GP08	Gel Pen	M&G	K3
GP09	Gel Pen	Test Good	Zhi Xin
GP10	Gel Pen	Reynolds	Racer Gel