Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	FOOD INSTRUMENTATION
COURSE CODE	:	BWD 21703
PROGRAMME CODE	:	BWD
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES

PART A

Q1 (a) Fill in the blanks in the following paragraphs. You may use the words given in *italic*.

air, capillary electrophoresis, charge, deoxyribonucleic acid, electric field, gel, gel electrophoresis, ground, handpumps, isoelectric focusing, protein, ribonucleic acid, separation, size, two-dimensional electrophoresis, water

Electrophoresis is a laboratory technique that is commonly used to separate and analyze molecules based on their ___(i)___, ___(ii)___and other properties. The technique involves applying an ___(iii)___to a gel matrix or other medium containing the sample mixture, which causes the charged molecules to move through the matrix at different rates based on their size and charge. This ___(iv)___allows for the identification and quantification of individual molecules within the sample mixture. There are several types of electrophoresis, each designed for specific applications. ___(v)___is one of the most used types of electrophoresis.

This technique uses a gel matrix made of either agarose or polyacrylamide to separate ___(vi)___, ___(vii)___and proteins based on their size. Gel electrophoresis can be used for a wide range of applications, including genotyping, DNA sequencing, and protein analysis. Another type of electrophoresis is ___(viii)___. This technique separates molecules based on their isoelectric point (pI), which is the pH at which the molecule has no net charge. It is often used for ___(ix)___analysis and can be used to identify protein isoforms. The last one is ___(x)___.This technique combines two different types of electrophoresis to separate molecules based on both their charge and size. It is often used for proteomics research to identify and analyze large numbers of proteins in complex mixtures.

(10 marks)

(b) Solvent passes through a chromatography column in 4.0 min but solute requires 10.0 min.

(i) Calculate the retention factor, R_f.

(2 marks)

(ii) What fraction of the time is the solute in the mobile phase in the column?

(2 marks)

(iii) The volume of the stationary phase (V_s) is $\frac{1}{10}$ of the volume of the mobile phase (V_m) of the column ($V_s = 0.10V_m$). Find the partition coefficient, K, for this system.

(2 marks)

(iv) Consider a chromatography column in which $V_s = \frac{Vm}{5}$. Find the retention factor if K = 2 and if K = 20.

(4 marks)

Q2 Scanning electron microscope (SEM) is an effective instrument for analysing the microstructure and texture of food.

(a) Propose a microstructural principle for the interactions between carbohydrates, lipids, and proteins in foods.

(5 marks)

(b) Illustrate the surface morphology image that a researcher could obtain by utilizing SEM and transmission electron microscope (TEM).

(5 marks)

(c) How can SEM be used to identify the cause of textural changes in a food product during storage?

(5 marks)

(d) Based on the answer given in **Q2**(c), what processing or formulation changes could enhance its stability?

(5 marks)

Q3 (a) Discuss how differential scanning calorimetry (DSC) is utilized in the determination of the following:

(i) Thermal stability of a protein.

(4 marks)

(ii) The glass transition of potato flour.

(4 marks)

(iii) The enthalpy changes of oils and spreads.

(4 marks)

(b) Compare and contrast the application of differential thermal analysis (DTA) and DSC in food analysis and discuss the differences in the resulting plot properties.

(8 marks)

PART B

Instruction: Read the following questions carefully. Fill in the entire circle that corresponds to your answer for each question on OMR answer sheet.

Q4 FTIR spectroscopy is _____ technique.

(a) A dispersive

(b) An emission

(c) An absorbance

(d) A reflectance

(1 mark)

Q5 In what region of the spectrum does infrared radiation occur?

(a) At the low-energy end.

(b) Between the visible and ultraviolet regions.

(c) Between the visible and microwave regions.

(d) Between the visible and x-ray regions.

(1 mark)

Q6 What happens to a molecule after absorbing infrared radiation?

(a) It warms up.

(b) It flies around.

(c) It spins faster.

(d) It vibrates faster.

(1 mark)

Q7 What is the application of chromatography?

(a) It can be used as medicine.

(b) It can be used to make bombs.

(c) It can be used for finding clues at a crime scene.

(d) It can be used to measure the texture of food.

(1 mark)

Q8 In paper chromatography, the MOST soluble solute _____.

(a) Does not move from the start point

(b) Travels furthest away from the start point

(c) Stays closest to the start point

(d) Can be found in the middle of the chromatogram

(1 mark)

Q9 Which type of chromatography separates components based on their affinity for a stationary phase?

(a) Gas chromatography.

(b) Thin layer chromatography.

(c) Affinity chromatography.

(d) Ion exchange chromatography.

(1 mark)

Q10 If a dye is insoluble in water and cannot be separated using chromatography, how can it be tested to see if it is a mixture?

(a) Replace with filtration technique.

(b) Replace with distillation technique.

(c) Repeat the chromatography test using a different solvent such as acetone.

(d) Repeat the chromatography using water as the solvent and see if it separates this time.

(1 mark)

Q11 Which type of chromatography involves separating components based on their solubility in a mobile phase and a stationary phase?

(a) Gas chromatography.

(b) Thin layer chromatography.

(c) Partition chromatography.

(d) Ion exchange chromatography.

(1 mark)

Q12 Which type of detector is commonly used in chromatography to detect and quantify separated components?

(a) Mass spectrometer.

(b) Infrared spectrometer.

(c) Ultraviolet-visible spectrometer.

(d) Flame ionization detector.

(1 mark)

Q13 Which type of sample preparation technique is commonly used prior to chromatography used in food analysis?

(a) Extraction.

(b) Centrifugation.

(c) Filtration.

(d) All of the above.

(1 mark)

Q14 Which type of chromatography is commonly used for separating and analyzing amino acids in food?

(a) Gas chromatography.

(b) Thin layer chromatography.

(c) Ion exchange chromatography.

(d) Affinity chromatography.

(1 mark)

Q15 Which type of chromatography is commonly used for separating and analyzing sugars in food?

(a) Gas chromatography.

(b) Thin layer chromatography.

(c) Size exclusion chromatography.

(d) High performance liquid chromatography.

(1 mark)

Q16 Which of the followings is the most important factor in achieving good separation and resolution in chromatography used in food analysis?

(a) The mobile phase.

(b) The stationary phase.

(c) The type of detector.

(d) The sample preparation technique.

(1 mark)

Q17 Which of the following statements is correct about normal phase HPLC?

(a) The stationary phase is nonpolar, and the mobile phase is polar.

(b) The mobile phase is nonpolar, while the stationary phase is polar.

(c) Adding a more polar solvent to the mobile phase increases eluent strength.

(d) Adding a less polar solvent to the mobile phase increases eluent strength.

(1 mark)

Q18 Which of the following compounds would you expect to be the last to elute from a reverse-phase liquid chromatography column?

(a) CH_3OH.

(b) CH_3CH_2OH.

(c) $CH_3CH_2CH_2OH$.

(d) $CH_3CH_2CH_2CH_2OH$.

(1 mark)

Q19 Theoretical plates are employed in the _____.

(a) Determination of the thickness of the stationary phase

(b) Estimation of the column efficiency

(c) Measurement of analyte distribution between mobile and stationary phases

(d) All of the above

(1 mark)

Q20 What is the factor that limits the application of differential thermal analysis (DTA) method?

(a) Huge apparatus.

(b) Insensitivity.

(c) Highly reactive.

(d) Low growth rate.

(1 mark)

Q21 What kind of reference material is used in DTA?

(a) Chemically active.

(b) Physically active.

(c) Inert material.

(d) Having catalytic property.

(1 mark)

Q22 What is the difference between the heat capacity of a sample and the heat capacity of a reference material, in DSC?

(a) The heat capacity of a sample is always higher than the heat capacity of a reference material.

(b) The heat capacity of a sample is always lower than the heat capacity of a reference material.

(c) The heat capacity of a sample can be higher or lower than the heat capacity of a reference material, depending on the sample's composition.

(d) The heat capacity of a sample and the heat capacity of a reference material are always identical.

(1 mark)

Q23 How can DSC be used to determine the degree of crystallinity in a food product?

(a) By analyzing the enthalpy of melting of the sample.

(b) By analyzing the enthalpy of fusion of the sample.

(c) By analyzing the enthalpy of sublimation of the sample.

(d) By analyzing the enthalpy of vaporization of the sample.

(1 mark)

Q24 How can DSC be used to measure the oxidative stability of a food product?

(a) By measuring the rate of heat flow during oxidation.

(b) By measuring the rate of weight loss during oxidation.

(c) By measuring the rate of enthalpy change during oxidation.

(d) By measuring the rate of color change during oxidation.

(1 mark)

Q25 What information can be obtained from a DSC curve?

(a) The melting point of a food component.

(b) The glass transition temperature of a food product.

(c) The thermal stability of a food component.

(d) All the above.

(1 mark)

Q26 Which of the following is a common application of DSC in food analysis?

(a) Determining the sugar content of a food product.

(b) Measuring the amount of fat in a food product.

(c) Assessing the thermal stability of a food component.

(d) Analyzing the color of a food product.

(1 mark)

Q27 Which of the following is a benefit of using DSC in food analysis?

(a) It requires a small amount of sample.

(b) It is a fast and inexpensive method.

(c) It provides information about the physical and chemical properties of a food product.

(d) It is a non-destructive method.

(1 mark)

Q28 How does the rate of heating or cooling affect a DSC measurement?

(a) It does not affect the measurement.

(b) A slower rate of heating or cooling provides more accurate results.

(c) A faster rate of heating or cooling provides more accurate results.

(d) A faster rate of heating or cooling can cause the sample to degrade.

(1 mark)

Q29 Which of the following is a disadvantage of using DSC in food analysis?

(a) It requires a large amount of sample.

(b) It is a slow and expensive method.

(c) It cannot distinguish between different food components.

(d) It is a destructive method.

(1 mark)

Q30 Which of the following is a key parameter that can be measured using DSC?

(a) The water activity of a food product.

(b) The pH of a food product.

(c) The enthalpy of a phase transition in a food product.

(d) The viscosity of a food product.

(1 mark)

Q31 Which of the following is a potential application of DSC in food product development?

(a) Optimization of cooking times and temperatures.

(b) Development of new food additives.

(c) Shelf-life determination of food products.

(d) All of the above.

(1 mark)

Q32 Which of the following is a limitation of using DSC in food analysis?

(a) It requires a complex sample preparation process.

(b) It is affected by the presence of impurities in the sample.

(c) It can only be used to analyze solid food products.

(d) It is not a sensitive method for detecting minor changes in food products.

(1 mark)

Q33 In colorimetry, what is the International Commission on Illumination (CIE) color space?

(a) A color model that describes colors as they appear to the human eye.

(b) A color model that describes colors as they are produced by light sources.

(c) A color model that describes colors as they are perceived by animals other than humans.

(d) A color model that describes colors as they are produced by chemical reactions.

(1 mark)

Q34 What is the difference between colorimetry and spectrophotometry?

(a) Colorimetry is a non-destructive method while spectrophotometry is a destructive method.

(b) Colorimetry measures the color of a sample while spectrophotometry measures the absorption of light by a sample.

(c) Colorimetry measures the transmittance of light through a sample while spectrophotometry measures the reflectance of light from a sample.

(d) Colorimetry is a visual method while spectrophotometry is an instrumental method.

(1 mark)

Q35 Which of the following is a common color scale used in colorimetry?

(a) RGB.

(b) CMYK.

(c) HSB.

(d) L*a*b*.

(1 mark)

Q36 What is the purpose of a colorimeter standardization procedure?

(a) To ensure that the colorimeter is operating at its maximum sensitivity.

(b) To ensure that the colorimeter is calibrated to a known color scale.

(c) To ensure that the colorimeter is free from contamination.

(d) To ensure that the colorimeter is properly maintained.

(1 mark)

Q37 How can colorimetry be used to detect food fraud?

(a) By comparing the color of a food product to a database of known authentic products.

(b) By measuring the reflectance of a food product and comparing it to a standard range.

(c) By measuring the transmittance of a food product and comparing it to a standard range.

(d) By measuring the fluorescence of a food product and comparing it to a standard range.

(1 mark)

Q38 How can colorimetry be used to optimize the appearance of a food or food product?

(a) By adjusting the ingredients and processing parameters to achieve a desired color.

(b) By analyzing the color of competitive products and replicating them.

(c) By manipulating the lighting conditions during food preparation and packaging.

(d) All of the above.

(1 mark)

Q39 Which of the following color spaces is commonly used in food analysis?

(a) RGB color space.

(b) CMYK color space.

(c) HSL color space.

(d) CIELAB color space.

(1 mark)

Q40 Which of the following parameters is typically measured in colorimetry analysis?

(a) Absorbance.

(b) Reflectance.

(c) Transmittance.

(d) All of the above.

(1 mark)

Q41 Which of the following is a limitation of using colorimetry in food analysis?

(a) It can only be used to analyze solid food or food products.

(b) It is affected by the presence of impurities in the sample.

(c) It cannot provide information about the chemical composition of a food or food product.

(d) It is not a sensitive method for detecting minor changes in food or food products.

(1 mark)

Q42 Which of the following instruments is commonly used in colorimetry analysis?

(a) A spectrophotometer.

(b) A gas chromatograph.

(c) An atomic absorption spectrophotometer.

(d) A pH meter.

(1 mark)

Q43 How does the illuminant used in colorimetry analysis affect the measurement?

(a) It does not affect the measurement.

(b) It can affect the hue and saturation of the color measurement.

(c) It can affect the brightness of the color measurement.

(d) It can affect the chemical composition of the sample.

(1 mark)

- END OF QUESTIONS -