

दिल्ली विश्वविद्यालय

UNIVERSITY OF DELHI

Bachelor of Science in Food Technology
or
**Bachelor of Science (Hons.) Food Technology with
Dissertation/ Academic Projects/ Entrepreneurship**

*Under UGCF-2022 based on NEP-2020
(Effective from Academic Year 2022-23)*



*Syllabus as
approved by
Academic
Council*

Date:

No:

Executive Council

Date:

No:

Department of Home Science
Semester -VII
B.Sc (Honours) Food Technology

Paper No	Paper Title	Credits	
		Theory	Practical
DSC FT 19	Statistical Analysis in Research	3	1
DSE FT 05	Sensory Science	2	2
DSE FT 06	Nutraceuticals and Functional Foods	2	2
DSE FT 07	Food Additives	2	2

DISCIPLINE SPECIFIC CORE COURSE
DSC FT 19: STATISTICAL ANALYSIS IN RESEARCH

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical		
Statistical Analysis in Research DSC FT 19	4	3	0	1	Studied XII	Nil

Learning Objectives

- Introduce students to basic statistical concepts and methods.
- Develop skills to organize, analyze and interpret data.
- Provide the foundation for applying statistical methods in real-world scenarios.
- Equip students with tools for making inferences from data using probability and hypothesis testing.
- Apply the concepts learned in real life food technology and nutrition data.

Learning Outcomes

- Understand and apply basic statistical concepts.
- Organize and summarize data using descriptive statistics.
- Understand probability theory and apply it to various problems.
- Conduct hypothesis testing and interpret the results.

- Understand the relevance of statistics in the area of food science and nutrition research.

SYLLABUS OF DSC FT 19

THEORY (Credits 3; Hours 45)

Unit I: Basics of Statistics

16 Hours

In this unit, students will learn to classify data, understand types of statistics, and collect, organize, present, analyze and interpret data. They will study central tendency and dispersion, and apply these concepts through case studies such as nutrition surveys, food preference analysis, and nutrient intake calculations or other examples from food industries.

- Definition, Scope, types and limitations of statistics
- Data vs Information, variable, frequency, frequency distribution, sample, population, univariate, bivariate and multivariate data tables, types of data (qualitative & quantitative), sources of data (primary and secondary), visualization of data.
- Level of measurement: Nominal, Ordinal, Interval & Ratio with real life examples
- Importance of Reliability and validity
- Meaning and Measures of Central Tendency- Arithmetic mean, geometric mean and harmonic mean, median, mode, their properties and relationship
- Partition values (Quartile, Decile, Percentile), Percentile vs Percentile Rank for ungrouped and grouped data. Examples from food industry and nutrition eg. use of percentile rank in evaluating shelf life, use of quartiles in classifying foods based on sugar content or any other relevant examples.
- Z-scores- examples from food industry, sensory evaluation, anthropometry, any other.
- Meaning and Measures of Dispersion (Variability): Absolute Vs Relative Dispersion and its various types explained using real life examples from ungrouped and grouped data sets, The Coefficient of Variation (CV) as a useful statistical measure in food science and nutrition for assessing the variability of data
- Skewness & Kurtosis

Unit II: Probability and Probability Distributions

8 Hours

In this unit, the students will understand the concepts of probability and probability distribution in food science and nutrition for risk assessment, quality control, and understanding nutrient requirements etc.

- Probability: Basic concepts, addition and multiplication rules of probability, conditional probability, Bayes theorem and its applications in Food Sciences.
- Probability Distribution: Definition of Random variable: Discrete (Binomial and Poisson probability distribution) and Continuous (Normal distribution) random variables, properties of Normal distribution, area under the normal curve. Examples like energy intake data, food safety violations, nutrient requirements, microbial contamination and product quality.
- Mathematical Expectation and Variance

Unit III: Correlation and Linear Regression

7 Hours

The students will learn correlation and regression which will help them understand relationships between variables, predict outcomes, and optimize processes.

- Correlation Analysis: Definition, Types of correlation, measure of correlation (Scatter diagram, Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient), coefficient of determination, properties of coefficient of correlation.
- Regression Analysis: Meaning of regression, Regression Lines (regression equations), regression coefficients along with their properties, Simple Linear Model (SLM). Examples such as the link between saturated fat consumption and cholesterol levels.

Unit IV: Sampling & Hypothesis Testing

14 Hours

This unit will help students understand the concepts of sampling, hypotheses testing, types of errors, and parametric and non-parametric tests as crucial tools in food science for ensuring food safety, quality, and optimizing processes, analysis of food products, packaging, and production methods by drawing conclusions about a larger population based on data from a sample.

- Sample, population, techniques of sampling, sample size, sampling distribution, standard error, null and alternate hypothesis, one-tail and two tail test, type I and type II errors and their probabilities α and β , level of significance (α) & level of confidence (C), concept of confidence interval estimation, Power of the test ($1-\beta$).

Parametric tests:

- Large sample tests for single mean and difference of means
- Student t-distribution: test for single mean, unpaired and paired t- test,
- F-test and one-way analysis of variance (ANOVA)
- Karl Pearson's (Product moment) Coefficient of correlation

Non-parametric test:

- Chi-square distribution: test for goodness of fit, test for independent attributes
- Test the significance of Spearman's rank correlation coefficient.

Practical (Credit 1; Hours 30)

Understanding the following concepts using any statistical software like MS-Excel, SPSS, JASP and open source softwares R, Jamovi etc:

1. Graphical Representation of Data
2. Measures of central tendency, partition values, variability and Shape
- 3 Normal distribution (Continuous distribution)
4. Correlation and linear regression analysis

5. Student t- test (one sample and 2 sample)

6. Chi-square test

7. ANOVA (one way)

Data sourced from ICMR, WHO, MOFPI or any other.

Essential Readings

- Minium, E. W., King, B. M., & Bear, G. (2017). Statistical Reasoning for Psychology and Education. New York: Wileyand Sons.
- Rastogi Veer Bala, Fundamentals of Biostatistics, latest edition.
- Gupta, S.P. (2022)Statistical Methods, 46th Edn. S.Chand and Sons.
- Agresti, A., Christine Franklin, C. and Klingenberg, B. (2017). Statistics: The Art and Science of Learning from data, Pearson, Boston.
- Biostatistical Analysis, 5th edition (2009), Jerrold H. Zar, Pearson. ISBN-13: 978-0131008465

Suggested Readings

- Derek, R. (2018). Statistics Without Tears, An Introduction for Non-Mathematicians ISBN:978-0-141-98749-1.
- Schmuller, J.(2016). Statistical Analysis with Excel for Dummies, 5th Edition, New York, USA.
- Gupta, S. C. & Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th Edn., S. Chand and Sons. ISBN: 9781119844549
- Ross, Sheldon M. (2010): Introductory Statistics, 3rd Edition, Academic Press.

Examination scheme and mode shall be as prescribed by the Examination branch, University of Delhi, from time to time

DISCIPLINE SPECIFIC ELECTIVE COURSE
DSE FT 05: SENSORY SCIENCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical		
Sensory Science DSE FT 05	4	3	0	1	Studied XII	Nil

Learning Objectives

1. To appreciate the significance of sensory science in food product designing and development.
2. To understand the physiology and mechanism of taste, aroma, texture and colour perception.
3. To study the various instrumental techniques/ measurements used in evaluating sensory attributes of food.

Learning Outcomes

- Apply the principles of sensory science in product development, reformulation and optimization, packaging, storage, and studies on alternative of foods.
- Assess colour, flavour, texture, and other sensory characteristics of food for quality assurance.
- Evaluate consumer perception and acceptance of food products.

SYLLABUS OF DSE FT 05

THEORY
(Credit 2; Hours 30)

UNIT I: Gustation

8 Hours

Unit description: This unit will focus on the physiology of taste, its perception and evaluation techniques.

- Introduction and importance of gustation
- Structure and physiology of taste organs- tongue, papillae, taste buds, salivary glands

- Mechanism of taste perception
- Chemical dimensions of basic tastes- sweet, salt, sour, bitter and umami
- Factors affecting taste quality, reaction time, taste modification, absolute and recognition threshold
- Recent advances in Taste measurement- Electronic Tongue
- Taste abnormalities

UNIT II: Olfaction

7 Hours

Unit description: This unit will focus on the physiology of smell, its perception and evaluation techniques.

- Introduction, definition and importance of odour and flavour.
- Anatomy of nose, physiology of odour perception
- Pre-requisites of odour perception.
- Mechanism of odour perception
- Recent advances in olfaction measurement – Electronic Nose
- Olfactory abnormalities

UNIT III: Colour

7 Hours

Unit description: This unit will focus on the importance of colour, its perception and evaluation techniques.

- Introduction and importance of colour
- Dimensions of colour.
- Attributes of colour; gloss etc.
- Perception of colour
- Colour Measurement: Hunter colour system, Tintometer.
- Colour abnormalities

UNIT IV: Texture

8 Hours

Unit description: This unit will focus on texture, its significance, physiology, and measurement.

- Introduction, definition, and importance of texture.
- Significance of sound in texture evaluation
- Physiology of Sense of Touch
- Texture perception
- Phases of oral processing.
- Receptors involved in texture evaluation.
- Texture measurement – basic rheological models, forces involved in texture measurement.

PRACTICAL (Credit 2, Hours 60)

1. Training of sensory panel.
2. To perform recognition tests for basic tastes.

3. To perform various Analytical tests
 - a. Discriminative Tests: Simple and directional Difference tests, Ranking and Rating Tests.
 - b. Sensitivity Tests: Threshold, /Dilution for basic tastes
 - c. Descriptive Tests: Category Scaling (structured and unstructured) Quantitative Descriptive Analysis.
4. To perform Affective Tests (Preference and Acceptance Tests)
 - a. Hedonic Scale (verbal, facial)
 - b. Food Action Scale
5. Perform sensory evaluation of any dairy product-market milk/cheese/butter/ice cream.
6. Analyze flavour defects in milk/ ice-cream/ butter.
7. Colour measurement using Lovibond Tintometer/ Hunter Colour Lab.

Essential Readings

- Rao, E. S. (2013). Food Quality Evaluation (I ed.). Variety Book Publishers, New Delhi.
- Herbert S., Rebecca B., & Heather T. (2020) (5th ed.) *Sensory Evaluation Practices*. Elsevier.
- Meilgard (2014). Sensory Evaluation Techniques (3rd ed.). CRC Press LLC.

Suggested Readings

1. George, A. B. (2004). Fenaroli's Handbook of Flavor Ingredients (5th ed.). CRC Press
2. Harry, T. L. & Barbara, P. K. (1991) Sensory Science Theory and Applications in Food. New York: Marcel Dekker.
3. Morton, I. D. & Macleod, A. J. (1990). Food Flavours. *Part A, B & C*. Elsevier.
4. Rao, E. S. (2014). Food Quality Testing and Evaluation: Sensory Tests and Instrumental Techniques. New Delhi. Variety Book Publishers

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DISCIPLINE SPECIFIC ELECTIVE
DSE FT 06: NUTRACEUTICALS AND FUNCTIONAL FOODS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE

Course Title & code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Theory	Tutorial	Practical/ Practice		
Nutraceuticals And Functional Foods DSE FT 06	4	2	0	2	Completed VI semester	Should have studied Biology/Biochemistry/Chemistry/Biomedical Science/Home Science in previous semesters

Learning Objectives

- To understand the types of nutraceutical and functional foods
- To understand the potential of various nutraceuticals and functional foods in promoting human health
- To understand the safety issues and consumer acceptance of nutraceutical and functional foods
- To understand labeling, marketing and regulatory issues related to nutraceutical and functional food
- To understand the processing technologies related to development of nutraceuticals and functional foods.

Learning Outcomes

- Differentiate between nutraceuticals and functional foods based on their composition and form.
- Understand the potential health benefits of consuming nutraceuticals and functional foods.

- Knowledge on safety issues and consumer acceptance of nutraceutical and functional foods, including the importance of regulation and quality control.
- Understand the labelling, marketing, and regulatory issues related to nutraceutical and functional food
- Knowledge of the processing technologies involved in the development of nutraceuticals and functional foods.

SYLLABUS OF DSE FT06

Theory (Credits 2; Hours 30)

UNIT I: Introduction

4 Hours

The unit will provide information on nutraceuticals, functional foods and nutrigenomics- definitions, differences, market trends, safety, labeling, regulatory issues, assessment of health claims.

- Definitions and history
- Difference between nutraceuticals and functional foods
- Current status and market trends of nutraceuticals and functional foods in India
- Nutrigenomics and its relation to nutraceuticals

UNIT II: Nutraceutical and functional foods

17 Hours

The unit will provide knowledge on different types of nutraceuticals and their sources, as well as the health benefits associated with their consumption. It also explores the different categories of functional foods, providing definitions and examples for each category.

- Types of nutraceuticals (definition, sources and health benefits):
 - phytochemicals- isoprenoids, polyphenolics, phytosterols
 - carbohydrates- (dietary fibers, oligosaccharides and resistant starch)
 - proteins and peptides
 - lipids- conjugated linoleic Acid, omega-3 fatty acids
 - microbial- prebiotics, probiotics, synbiotic, postbiotics

Categories of functional foods: traditional, fortified, altered, enriched and enhanced foods- definition and examples

UNIT III: Technologies in nutraceutical and functional food development

5 Hours

This unit covers the processing technologies used for extracting bioactive components and nutraceuticals from functional foods. It also discusses the challenges and limitations of delivering nutraceuticals in food.

- Processing Technologies for Functional Foods, Bioactive Components and Nutraceutical Products- Soxhlet extraction, supercritical fluid extraction, microwave assisted and combined extraction process
- Delivery of Nutraceuticals in Food and its limitations

UNIT IV: Safety and regulatory aspects in nutraceuticals and functional foods 4 hours

This unit covers the safety, labelling and marketing regulations, and assessment of health claims with an understanding of national and international regulations.

- Safety and labelling
- Marketing and regulatory issues
- Assessment of health claims
- Role of FSSAI and Codex

PRACTICAL (Credits 2; Hours 60)

1. Identification of various nutraceuticals and functional foods available in the market.
2. Estimation of chlorophyll content.
3. Determination of lycopene.
4. Determination of anthocyanins.
5. Estimation of free radical scavenging activity/antioxidant activity by DPPH/FRAP.
6. Estimation of total phenolic content.
7. Estimation of flavonoid content.
8. Development of a functional food.

Essential readings

- Wildman, R.E.C. (2019). Handbook of Nutraceutical and Functional Foods. 3rd ed, CRC Press
- Joyce I. B. (2015). Nutraceutical and Functional Food Processing Technology. United Kingdom: Wiley.

- Bagchi, D., Sreejayan, N. (2016). Developing New Functional Food and Nutraceutical Products. Netherlands: Elsevier Science.
- Egbuna, C., Tupas, G. D. (2020). Functional Foods and Nutraceuticals: Bioactive Components, Formulations and Innovations. Germany: Springer International Publishing.

Suggested readings

- Ranganna, S. (1986). Handbook of analysis and quality control for fruits and vegetable products. Tata McGraw-Hill publishing company limited, Second edition
- Galanakis, C. M. (Ed.). (2021). Nutraceutical and functional food components: Effects of innovative processing techniques. Academic Press.
- Aluko, R. E. (2012). Functional foods and nutraceuticals (pp. 37-61). New York, NY, USA: Springer.

Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE**DSE FT 07: FOOD ADDITIVES****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE**

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Food Additives DSE FT 07	4	2	0	2	Studied XII	PCM/PCB

Learning Objectives

- To understand the significance of food additives in food processing and preservation.
- To appreciate the technological functions of additives in foods.
- To comprehend the chemistry and toxicological aspects of food additives.

Learning Outcomes

- Apply the knowledge of food additives in food processing and preservation.
- Appreciate the chemical, technological functions, and toxicological evaluation of food additives in food preservation.

SYLLABUS OF DSE FT 07**THEORY**
(Credit 2; Hours 30)**UNIT I: Introduction to Food Additives****8 Hours**

Unit description: The unit will provide information on the classification, significance, toxicological evaluation and regulatory aspects of food additives used in food processing and preservation.

- Definition, classification, and significance of food additives in food processing and preservation.
- Food Category System of FSSAI- Vertical and Horizontal standards.

- Toxicological evaluation of food additives -Risk assessment studies- Safety and quality evaluation of additives, Acute and chronic studies, NOAEL, ADI, LD₅₀
- Regulatory aspects of food additives.

UNIT II: Preservatives

7 Hours

Unit description: The unit will provide insight to different kinds of preservatives, their classification and mechanism of action, technological and toxicological aspects used in food industries.

- Importance, classification: Class I and Class II preservatives.
- Antimicrobials: mechanism of action, chemical, technological, and toxicological aspects- Sulfites, nitrates, benzoates, and their salts.

Unit III: Colours and Sweeteners

8 Hours

Unit description: This unit will focus on importance, classification, safety concerns and recent developments in colours and sweetening agents that are used in food industries.

- **Colours-** Importance and classification
- Application and their safety concerns.
- Recent developments in the food industry.
- **Sweeteners-** Importance and classification
- Consideration for choosing sweetening agents.
- Recent developments of sweeteners in food industry

Unit IV: Emulsifiers, Stabilizers, Thickeners

7 Hours

Unit description: There are various emulsifiers, stabilizers and thickeners that are used in food industries. This unit will introduce functions, mechanism of action and recent developments in these in the food industry

- Introduction, functions, and mechanism of action
- Permitted emulsifiers, stabilizers, thickeners used in foods.
- Recent developments in the food industry.

PRACTICAL (Credit-2; Hours 60)

1. Qualitative estimation of Sulphur dioxide in beverages.
2. Quantitative estimation of Sulphur dioxide in beverages.
3. Qualitative estimation of benzoic acid in ketchup and sauces.
4. Extraction of food pigments and effect of heat and pH on stability.
5. Paper chromatographic estimation of colours.
6. Analysis of moisture content in different edible salts.
7. Analysis of matter insoluble water (MIW) and total chlorides in edible salt.

Essential Readings

- Sen, M. (2021). Food Chemistry: The Role of Additives, Preservatives and Adulteration. United States: Wiley.

- Brannen, D., & Salminen, T. (2002). *Food Additives*. 2nd edition. New York: Marcel Dekker, Inc.
- Fennema, O. R. (1996). *Food chemistry* (Vol. 76). CRC Press.
- Baines, D., & Seal, R. (Eds.). (2012). *Natural food additives, ingredients, and flavourings*. Elsevier.
- Msagati, T. A. M. (2013). Chemistry of food additives and preservatives: emulsifiers.

Suggested Readings

- Codex Alimentarius Commission (2001). Class names and the international numbering system for food additives. Codex Alimentarius: Vol. 1A—General Requirements.
- WHO (1987). Principles for the safety assessment of food additives and contaminants in food. Environmental Health Criteria 70. World Health Organization, Geneva.
- FDA. (1993). Toxicological Principles for the Safety Assessment of Direct Food Additives and Colour Additives used in Food (Redbook II). National Technical Information Services, Springfield, Virginia.
- Emerton, Victoria, “Food Colours”. Blackwell Publishing, 2008.
- Mahindru, S. N. (2000) Food Additives- Characteristics Detection and Estimation, TATA McGraw Hill.
- DeMan. (2007). *Principles of Food Chemistry*. Springer, 3rd edition.
- Davidson, P. M., & Branen, A. L. (1993). Antimicrobials in Foods. Marcel Dekker, New York.

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GENERIC ELECTIVE COURSE
GE FT07- Processing of Meat and Marine Foods

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Processing of Meat and Marine Foods	4	3	0	1	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows

1. To understand aspects of Indian Meat industry, meat quality and slaughter processes
2. To acquire the knowledge of fish preservation and value-added fish products

Learning outcomes

The Learning Outcomes of this course are as follows:

1. Understand the need and importance of meat and marine industry.
2. Comprehend meat and marine processing & technology.
3. Acquire knowledge about meat and fish by-products
4. Understand preservation of fish

SYLLABUS

THEORY
(Credits 3; Hours 45)

Unit I: Meat quality, slaughter process and by-products. 15 Hours

- Status of livestock population in India, development of meat industry in India.
- Colour and texture of meat (Water holding capacity, Emulsification capacity of meat).
- Slaughter, antemortem and postmortem examination of Sheep/Goat.
- Classification of meat byproducts and uses

Unit II: Fish quality and Low Temperature Preservation 15 Hours

- Status of fishery industry in India.
- Fish: characteristics and structure of fish muscle, Effect of method of catching and handling on the quality of fish, post mortem changes, rigor mortis, autolytic changes, changes in fish proteins on storage, spoilage of fish, packaging of fish, contaminants and naturally occurring toxicants in fish

- Relationship between chilling and storage life, MAP, general aspects of freezing, freezing systems (air blast freezing, plate or contact freezing spray or immersion freezing, freezing on board, onshore processing, changes in quality in chilled and frozen storage, thawing.

Unit III: Processing of Meat and Fish

15 Hours

Canning of Meat, Sausage classification and manufacture, Retort pouch meat, Traditional Meat products of India

- Salting of fish, salting methods (brining, pickling, kench curing, gaspe curing), Salted fish products- pindang, fishwood.
- Drying and Smoking: Smoke production, smoke components, quality, safety and nutritive value of smoked fish, processing and equipment, pre-smoking processes, smoking process control.
- Principles of canning of fish, canning of (Tuna, Mackerel, Sardine).
- Basic concepts of Surimi and fish mince products.

PRACTICAL 1 Credit (30 Hrs)

- Analysis of frozen meat / meat emulsion product.
- Cut out analysis of canned meat/retort pouches (Internal parameters) .
- Cut out analysis of canned meat/retort pouches (External parameters).
- Cut out analysis of canned fish (Sardine/Mackerel/Tuna) (Internal parameters).
- Cut out analysis of canned fish (Sardine/Mackerel/Tuna) (External parameters).
- Estimation of moisture content in meat.
- Preparation of Meat/fish product (Ideation/development of product).
- Subjective evaluation of Fresh Fish.
- Quality assessment of market sample of processed fish products.

Essential Readings (Theory)

1. Hall, G.M. (1997). Fish Processing Technology. 2nd ed., Blackie Academic and Professional, an imprint of Chapman & Hall., NY.
2. Sen, D.P. (2005). Advances in Fish Processing Technology, Allied Publishers Pvt. Limited.
3. Lawrie, R. A. (2017). Lawrie's meat science. 8th ed. England: Woodhead Publishing Ltd.
4. Martin, R.E., Collete, R.L. and Slavin, J.W. (1998). Fish Inspection, Quality Control

- and HACCP: A Global Focus.1st ed. (Eds), CRC Press,
5. Borda, D., Nicolau. A. I. and Raspor, P. (2017). Trends in Fish Processing Technology (Contemporary Food Engineering Series). 1st edition, Taylor & Francis.
 6. Hall GM, Fish Processing Technology, VCH Publishers Inc., NY, 1992.
 7. Lawrie R A, Lawrie's Meat Science, 5th Ed, Woodhead Publisher, England, 1998