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UGC NET Paper – 2 (HOME SCIENCE)

I UNIT

Food Science and Food Service Management

Food Science and Nutrition

1.1 Definition and Interdisciplinary Nature

Food Science is a multidisciplinary field that applies principles of chemistry, biology, physics, engineering, and microbiology to study the nature, composition, processing, preservation, and safety of food. It investigates how food behaves under various conditions—during storage, cooking, or industrial processing—and how these processes affect its sensory attributes (taste, texture, appearance) and nutritional quality. Food science also explores innovations like functional foods, nanotechnology, and sustainable packaging, which are increasingly relevant in the UGC NET JRF context.

Together, food science and nutrition form the backbone of Home Science, enabling professionals to:

- Develop nutritionally balanced food products.
- Design diets for diverse populations (e.g., infants, elderly, pregnant women).
- Ensure food safety and quality in processing and service.
- Address global challenges like food security and sustainability.

Diagram 1: Interdisciplinary Nature of Food Science and Nutrition

Description: A Venn diagram with three overlapping circles labeled "Food Science," "Nutrition," and "Home Science." The overlapping areas highlight shared domains:

- Food Science ∩ Nutrition: Food composition, nutrient retention during processing.
- Food Science ∩ Home Science: Food preparation, preservation techniques.
- Nutrition ∩ Home Science: Dietary planning, public health nutrition.
- Central overlap: Application in institutional food service, research, and product development.

Interdisciplinary Nature of Food Science and Nutrition

1.3 Food Composition

Foods are complex matrices of macronutrients, micronutrients, water, and non - nutrient components (e.g., fiber, phytochemicals). The composition varies across food groups, influencing their nutritional and functional properties.

1.3.1 Macronutrients

- **Carbohydrates**: Primary energy source (4 kcal/g). Types:
  - **Sugars**: Monosaccharides (glucose, fructose) and disaccharides (sucrose, lactose). Found in fruits, milk, and sweets.
  - **Starches**: Complex polysaccharides in cereals (rice, wheat), tubers (potatoes).
  - **Fiber**: Non - digestible carbohydrates (cellulose, pectin) in whole grains, vegetables, and fruits. Promotes gut health.
- **Proteins**: Essential for growth, repair, and immunity (4 kcal/g). Composed of amino acids:
  - **Essential Amino Acids (EAAs)**: Histidine, leucine, lysine, etc., must be obtained from diet.
  - **Non - Essential Amino Acids**: Synthesized by the body (e.g., alanine, glycine).
  - Sources: Pulses, meat, fish, eggs, dairy.
- **Lipids**: Concentrated energy source (9 kcal/g). Types:
  - **Triglycerides**: Fats (solid) and oils (liquid). Found in butter, vegetable oils.
  - **Phospholipids**: Cell membrane components (e.g., lecithin in soybeans).
  - **Sterols**: Cholesterol in animal foods; phytosterols in plants.
  - Functions: Energy storage, hormone synthesis, vitamin absorption.

1.3.2 Micronutrients

- **Vitamins**: Organic compounds required in small amounts.
  - **Fat - Soluble**: A (vision), D (bone health), E (antioxidant), K (blood clotting). Stored in liver and adipose tissue.
  - **Water - Soluble**: B - complex (metabolism), C (collagen synthesis, immunity). Excreted in urine, requiring regular intake.
- **Minerals**: Inorganic elements.
  - **Macrominerals**: Calcium (bones), phosphorus (energy metabolism), magnesium (muscle function).
  - **Trace Minerals**: Iron (oxygen transport), zinc (immunity), iodine (thyroid function).

1.3.3 Water

- Comprises 50–90% of food weight (e.g., 91% in spinach, 70% in rice).
- Functions: Hydration, nutrient transport, temperature regulation.

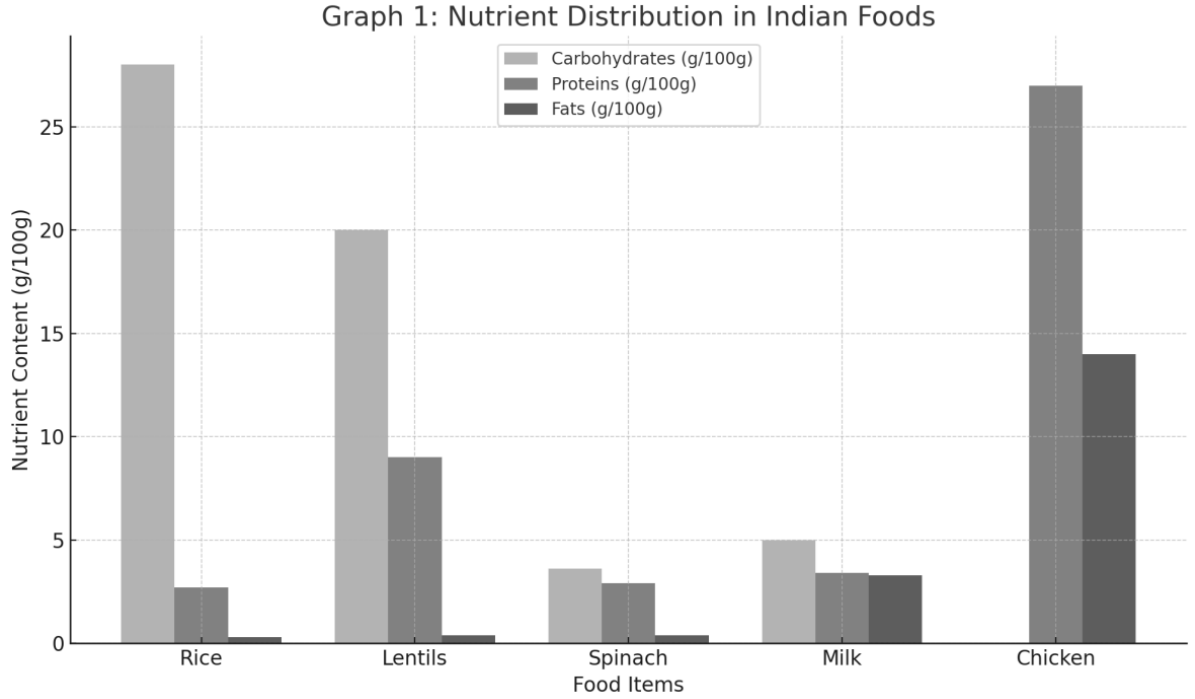
1.3.4 Non - Nutrient Components

- **Fiber**: Promotes digestion, reduces cholesterol.
- **Phytochemicals**: Antioxidants (e.g., flavonoids in berries, lycopene in tomatoes).
- **Enzymes**: Catalyze reactions (e.g., amylase in saliva).
- **Pigments**: Affect color (e.g., chlorophyll in greens).

Table 1: Composition of Common Indian Foods (per 100g)

Food Item	Carbohydrates (g)	Proteins (g)	Fats (g)	Water (g)	Fiber (g)	Key Micronutrients
Rice (cooked)	28.0	2.7	0.3	68.0	0.4	Thiamine, Iron
Lentils (dal)	20.0	9.0	0.4	70.0	8.0	Folate, Magnesium
Spinach	3.6	2.9	0.4	91.0	2.2	Vitamin A, K, Iron
Milk (cow)	4.8	3.3	3.5	87.0	0.0	Calcium, Vitamin D, B12
Chicken	0.0	27.0	14.0	59.0	0.0	Niacin, Selenium, B6
Mango	17.0	0.5	0.3	81.0	1.8	Vitamin C, A, Beta - carotene

Nutrient Distribution in Indian Foods



Description: A bar graph comparing macronutrient content (carbohydrates, proteins, fats) across rice, lentils, spinach, milk, and chicken. X - axis: Food items. Y - axis: Nutrient content (g/100g). Key observations:

- Rice: High carbohydrates (28g), low proteins (2.7g), negligible fats.
- Lentils: Balanced carbohydrates (20g) and proteins (9g).
- Spinach: Low macronutrients, high water, and micronutrients.
- Milk: Moderate proteins and fats, low carbohydrates.
- Chicken: High proteins (27g), moderate fats (14g), no carbohydrates.

1.4 Nutrient Functions and Deficiency Disorders

1.4.1 Carbohydrates

- **Functions**: Primary energy source, glycogen storage, sparing proteins from energy use.
- **Deficiency**: Rare; may cause ketosis (fat breakdown for energy).
- **Excess**: Leads to obesity, type 2 diabetes.

1.4.2 Proteins

- **Functions**: Tissue repair, enzyme and hormone synthesis, immune function.
- **Deficiency**: Protein - Energy Malnutrition (PEM):
  - **Kwashiorkor**: Protein deficiency, edema, fatty liver.
  - **Marasmus**: Energy deficiency, muscle wasting, stunted growth.
- **Excess**: Kidney strain, calcium loss.

1.4.3 Lipids

- **Functions**: Energy reserve, cell membrane structure, absorption of fat - soluble vitamins.
- **Deficiency**: Essential fatty acid deficiency (e.g., linoleic acid), causing skin issues, impaired growth.
- **Excess**: Obesity, cardiovascular diseases.

1.4.4 Vitamins

- **Vitamin A**: Vision, immunity. Deficiency: Night blindness, xerophthalmia.
- **Vitamin D**: Calcium absorption, bone health. Deficiency: Rickets (children), osteomalacia (adults).
- **Vitamin E**: Antioxidant. Deficiency: Rare, neurological issues.
- **Vitamin K**: Blood clotting. Deficiency: Hemorrhaging.
- **B - Complex**: Energy metabolism, nerve function.
  - Thiamine (B1): Deficiency causes beriberi.
  - Riboflavin (B2): Deficiency causes ariboflavinosis (mouth sores).

- Niacin (B3): Deficiency causes pellagra (dermatitis, diarrhea, dementia).
- Folate (B9): Deficiency causes megaloblastic anemia, neural tube defects.
- Vitamin B12: Deficiency causes pernicious anemia.

- **Vitamin C**: Collagen synthesis, immunity. Deficiency: Scurvy (bleeding gums, poor wound healing).

1.4.5 Minerals

- **Calcium**: Bone health, muscle contraction. Deficiency: Osteoporosis, tetany.
- **Iron**: Oxygen transport (hemoglobin). Deficiency: Iron - deficiency anemia.
- **Iodine**: Thyroid hormone synthesis. Deficiency: Goiter, cretinism.
- **Zinc**: Immunity, wound healing. Deficiency: Growth retardation, impaired immunity.
- **Magnesium**: Muscle and nerve function. Deficiency: Tremors, convulsions.

1.4.6 Water

- **Functions**: Solvent for biochemical reactions, temperature regulation, waste excretion.
- **Deficiency**: Dehydration, impaired cognition, kidney damage.
- **Excess**: Water intoxication (rare), causing hyponatremia.

Table 2: Nutrient Functions and Deficiency Disorders

Nutrient	Key Functions	Deficiency Disorder	Excess Effects
Carbohydrates	Energy, glycogen storage	Ketosis	Obesity, diabetes
Proteins	Tissue repair, immunity	Kwashiorkor, marasmus	Kidney strain, calcium loss
Lipids	Energy, vitamin absorption	Essential fatty acid deficiency	Obesity, heart disease
Vitamin A	Vision, immunity	Night blindness, xerophthalmia	Hypervitaminosis A (liver damage)
Vitamin C	Collagen synthesis, immunity	Scurvy	Kidney stones (high doses)
Iron	Oxygen transport	Anemia	Hemochromatosis
Calcium	Bone health, muscle function	Osteoporosis, tetany	Kidney stones, hypercalcemia
Iodine	Thyroid function	Goiter, cretinism	Thyroid dysfunction

Diagram 2: Nutrient Deficiency Pathway

Description: A flowchart showing the progression of nutrient deficiencies:

- Start: Inadequate dietary intake → Reduced nutrient levels in body → Impaired physiological functions → Clinical symptoms (e.g., anemia for iron, scurvy for vitamin C) → Severe health outcomes (e.g., organ damage, death if untreated).
- Example: Iron deficiency → Low hemoglobin → Fatigue, pallor → Anemia → Heart failure (extreme cases).

Example Pathway:
Iron Deficiency → Low Hemoglobin → Fatigue, Pallor → Anemia → Heart Failure (extreme cases)

1.5 Recommended Dietary Allowances (RDA)

The **Indian Council of Medical Research (ICMR)** and **National Institute of Nutrition (NIN)** provide RDA guidelines for nutrient intake based on age, gender, physiological status (e.g., pregnancy, lactation), and activity level. RDA ensures optimal health and prevents deficiencies.

Table 3: ICMR RDA for Adults (Moderate Activity, 2020)

Nutrient	Men (per day)	Women (per day)	Pregnant Women	Lactating Women
Energy (kcal)	2320	1900	+350	+600
Protein (g)	60	55	+23	+17
Fat (g)	25	20	+30	+30
Calcium (mg)	600	600	1200	1200
Iron (mg)	17	21	35	21
Vitamin A (µg)	600	600	800	950
Vitamin C (mg)	40	40	60	80
Folate (µg)	200	200	500	300

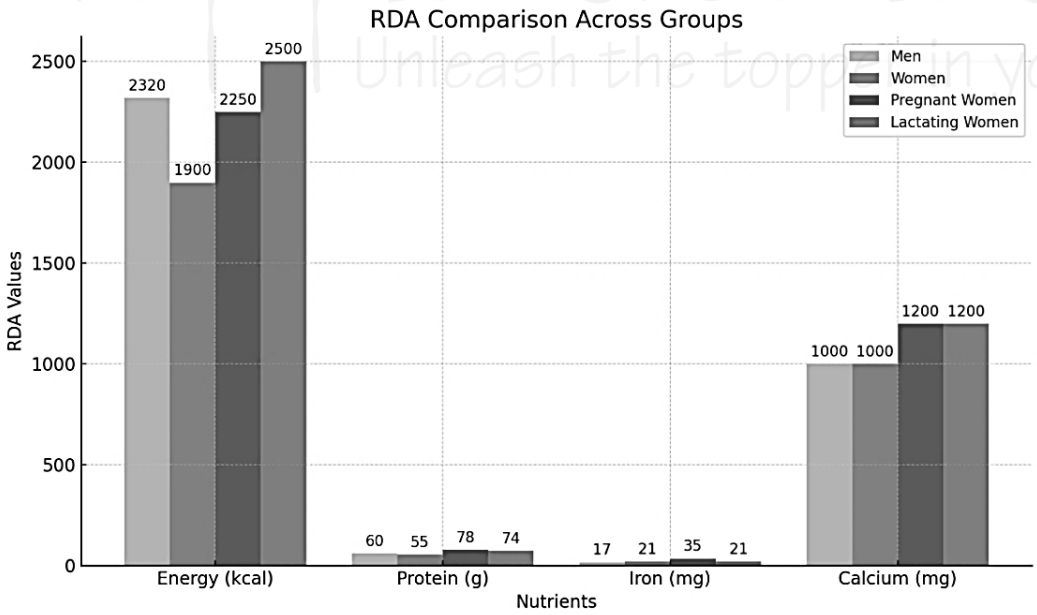
Key Points:

- **Energy**: Higher for men due to greater muscle mass; increases during pregnancy/lactation.
- **Protein**: Adjusted for growth needs (e.g., pregnancy).
- **Iron**: Higher for women due to menstrual losses; peaks in pregnancy.
- **Calcium**: Doubles in pregnancy/lactation for fetal bone development.

Graph 2: RDA Comparison Across Groups

Description: A clustered bar graph comparing RDA for energy, protein, iron, and calcium across adult men, women, pregnant women, and lactating women. X - axis: Nutrients. Y - axis: RDA values. Observations:

- Pregnant women have the highest iron (35 mg) and calcium (1200 mg) requirements.
- Men require more energy (2320 kcal) than women (1900 kcal).
- Protein needs peak in pregnancy (+23 g).



1.6 Balanced Diet and Dietary Guidelines

A **balanced diet** provides all nutrients in proportions that meet physiological needs, preventing deficiencies and excesses. It is based on:

- **Food Groups**: Cereals, pulses, vegetables, fruits, milk, meat, fats, sugars.
- **Portion Sizes**: Guided by ICMR's My Plate for the Day (NIN, 2020).
- **Variety**: Includes diverse foods to ensure micronutrient coverage.

ICMR - NIN Dietary Guidelines (2020):

- Eat a variety of foods to ensure nutrient adequacy.
- Consume adequate cereals and pulses for energy and protein.
- Include vegetables (300g/day) and fruits (100g/day) for micronutrients.
- Use milk and dairy for calcium and protein.
- Limit fats (20–30g/day) and sugars (<10% of energy).
- Ensure safe drinking water and hygiene.
- Promote breastfeeding for infants (0–6 months).
- Reduce salt intake to prevent hypertension (<5g/day).
- Include fortified foods (e.g., iodized salt, vitamin A - fortified oil).
- Encourage physical activity and healthy lifestyles.

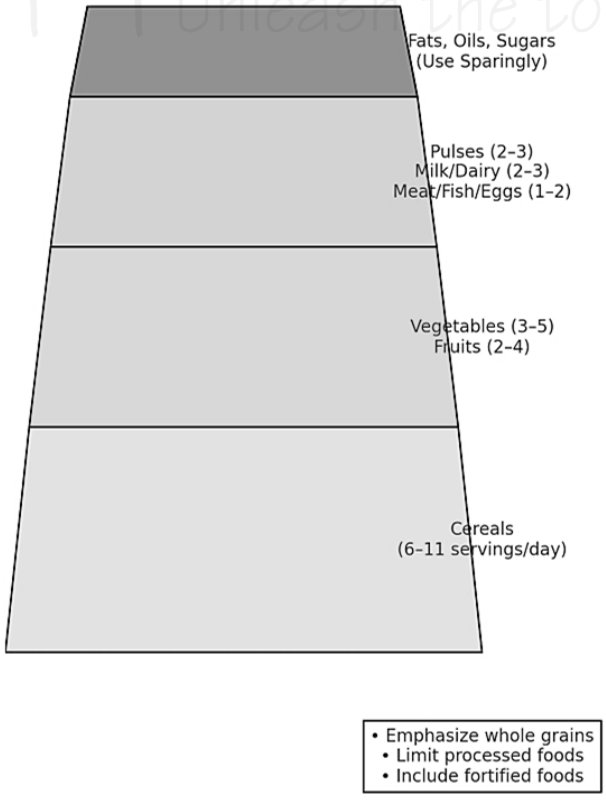
Table 4: My Plate for the Day (ICMR - NIN, Adults)

Food Group	Recommended Intake (g/day)	Key Nutrients Provided
Cereals	300–400	Carbohydrates, B vitamins
Pulses	60–90	Proteins, fiber, iron
Vegetables	300 (50 leafy)	Vitamins A, C, K, fiber
Fruits	100	Vitamin C, antioxidants
Milk/Dairy	300 (ml or equivalent)	Calcium, protein, vitamin D
Meat/Fish/Eggs	30–60	Proteins, iron, B12
Fats/Oils	20–30	Essential fatty acids, energy
Nuts/Seeds	20–30	Healthy fats, magnesium

Diagram 3: Balanced Diet Pyramid

Description: A food pyramid with tiers representing food groups:

- Base: Cereals (largest portion, 6–11 servings/day).
- Second tier: Vegetables (3–5 servings) and fruits (2–4 servings).
- Third tier: Pulses (2–3 servings), milk/dairy (2–3 servings), meat/fish/eggs (1–2 servings).
- Top: Fats, oils, sugars (use sparingly).
- Annotations: Emphasize whole grains, limit processed foods, and include fortified foods.



1.7 Public Health Nutrition

Public health nutrition addresses population - level nutritional challenges through interventions, policies, and education. In India, key issues include:

- **Undernutrition**: PEM, anemia, vitamin A deficiency, iodine deficiency disorders.
- **Overnutrition**: Obesity, diabetes, cardiovascular diseases.
- **Hidden Hunger**: Micronutrient deficiencies despite adequate energy intake.

1.7.1 Interventions

- **Fortification**: Adding nutrients to staple foods.
  - Iodized salt: Prevents iodine deficiency disorders.
  - Vitamin A - fortified edible oils: Reduces night blindness.
  - Iron - fortified wheat flour: Combats anemia.
- **Supplementation**: Providing nutrient supplements.
  - Iron - folic acid (IFA) tablets: For pregnant women and adolescents (National Iron Plus Initiative).
  - Vitamin A drops: For children 6–59 months.
- **Nutrition Education**: Promoting healthy eating through campaigns (e.g., Eat Right India by FSSAI).
- **Public Health Programs**:
  - **POSHAN Abhiyaan (2018)**: Aims to reduce stunting, undernutrition, and anemia.
  - **Mid - Day Meal Scheme**: Provides nutritious meals to schoolchildren.
  - **Integrated Child Development Services (ICDS)**: Supports maternal and child nutrition.

1.7.2 Challenges

- **Access**: Limited availability of nutrient - rich foods in rural areas.
- **Awareness**: Low knowledge of balanced diets.
- **Socioeconomic Factors**: Poverty, gender disparities.

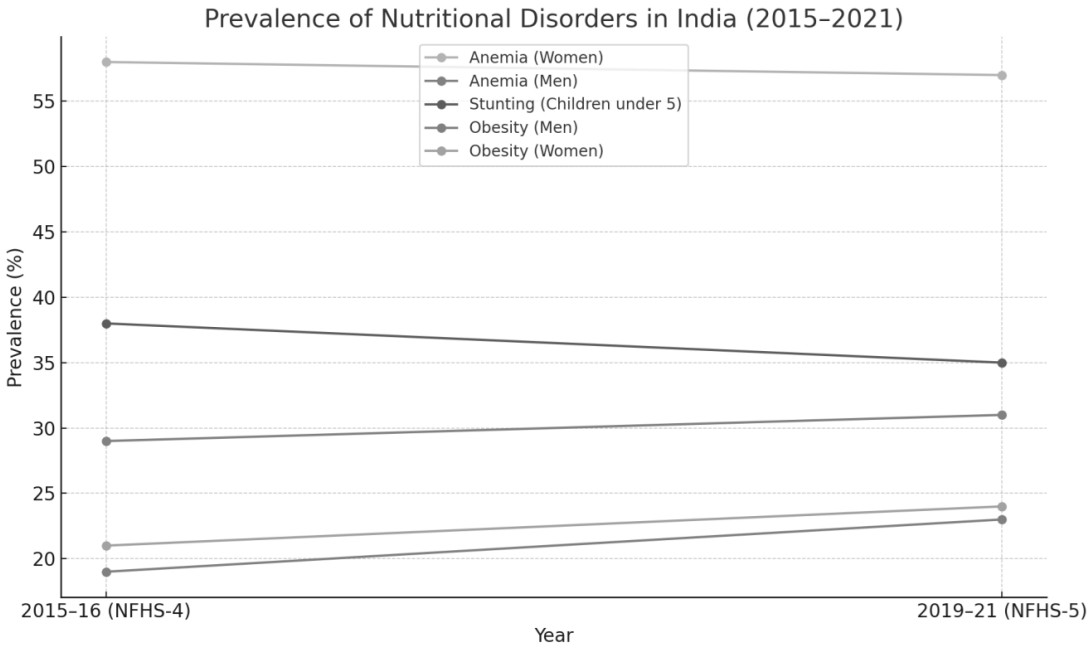
Table 5: Major Nutritional Deficiency Disorders in India

Disorder	Nutrient Involved	Prevalence (NFHS - 5, 2019–21)	Intervention
Anemia	Iron, Folate, B12	57% women, 31% men	IFA supplementation, fortification
Vitamin A Deficiency	Vitamin A	19% children (under 5)	Vitamin A prophylaxis
Iodine Deficiency	Iodine	1–2% (goiter prevalence)	Universal salt iodization
Stunting	Protein, Energy	35% children (under 5)	ICDS, POSHAN Abhiyaan
Obesity	Excess Energy	24% women, 23% men	Nutrition education, FSSAI norms

Graph 3: Prevalence of Nutritional Disorders in India

Description: A line graph showing trends in anemia, stunting, and obesity prevalence (2015–2021, NFHS - 4 and NFHS - 5). X - axis: Years (2015–16, 2019–21). Y - axis: Prevalence (%). Observations:

- Anemia: Slight decline in women (58% to 57%), increase in men (29% to 31%).
- Stunting: Decreased from 38% to 35% in children under 5.
- Obesity: Increased in both men (19% to 23%) and women (21% to 24%).



Sample PYQs:

Dec 2023:

Q. Which vitamin deficiency causes scurvy?

(A) Vitamin A (B) Vitamin C
(C) Vitamin D (D) Vitamin K

Answer: (B) Vitamin C

June 2022:

Q. What is the primary energy source in the Indian diet?

(A) Proteins (B) Carbohydrates
(C) Fats (D) Vitamins

Answer: (B) Carbohydrates

Dec 2021:

Q. Name the program for iodine deficiency prevention in India.

(A) POSHAN Abhiyaan
(B) National Iodine Deficiency Disorders Control Programme (NIDDCP)
(C) Mid - Day Meal Scheme
(D) ICDS

Answer: (B) NIDDCP

Properties of Food – Physical and Chemical Properties

2.1 Definition and Significance

The **properties of food** determine its quality, safety, sensory appeal, and suitability for processing, storage, and consumption. They are classified into:

- **Physical Properties**: Observable without altering chemical composition (e.g., texture, color, viscosity).
- **Chemical Properties**: Related to molecular composition and reactivity (e.g., pH, water activity, oxidative stability).

Significance:

- **Processing**: Guides selection of techniques (e.g., baking vs. frying based on texture).
- **Quality Control**: Ensures consistency in sensory and nutritional attributes.
- **Safety**: Influences microbial growth and shelf life (e.g., low pH in pickles).
- **Product Development**: Designs foods with desired attributes (e.g., creamy ice cream, crispy snacks).

2.2 Physical Properties

2.2.1 Texture

Texture is the sensory and structural quality of food perceived through touch, mouthfeel, or instruments. It includes:

- **Hardness**: Resistance to deformation (e.g., crispiness of papad).
- **Cohesiveness**: Ability to hold together (e.g., chewiness of naan).
- **Viscosity**: Flow resistance (e.g., thickness of dal).
- **Adhesiveness**: Stickiness (e.g., jalebi syrup).
- **Elasticity**: Ability to return to original shape (e.g., dough).

Measurement:

- **Sensory**: Trained panels use descriptive analysis (e.g., hedonic scale).

- **Instrumental**: Texture Profile Analysis (TPA) using texture analyzers measures parameters like hardness, springiness, and chewiness.

Example: The crispiness of fried samosas results from low moisture content and high fat absorption during frying.

Table 6: Texture Attributes and Examples

Attribute	Definition	Example Food	Measurement Method
Hardness	Resistance to deformation	Papad, biscuits	Texture analyzer (force)
Cohesiveness	Ability to hold together	Naan, cheese	TPA (cohesion ratio)
Viscosity	Resistance to flow	Dal, custard	Viscometer
Adhesiveness	Stickiness	Jalebi, caramel	TPA (adhesion force)
Elasticity	Return to original shape	Dough, mozzarella	TPA (springiness)

2.2.2 Color

Color affects consumer acceptance, indicates quality, and signals spoilage. It is determined by:

- **Pigments**:
  - **Chlorophyll**: Green (spinach, beans).
  - **Carotenoids**: Orange/yellow (carrots, mangoes).
  - **Anthocyanins**: Red/purple (beetroot, grapes).
  - **Betalains**: Red/yellow (beets).
- **Processing Effects**:
  - **Maillard Reaction**: Non - enzymatic browning (e.g., browning in bread crust).
  - **Caramelization**: Sugar browning (e.g., caramel).
  - **Enzymatic Browning**: Polyphenol oxidase activity (e.g., apples turning brown).
- **Measurement**: Colorimeters measure Lab* values:
  - L*: Lightness (0 = black, 100 = white).
  - a*: Red (+ve) to green (- ve).
  - b*: Yellow (+ve) to blue (- ve).

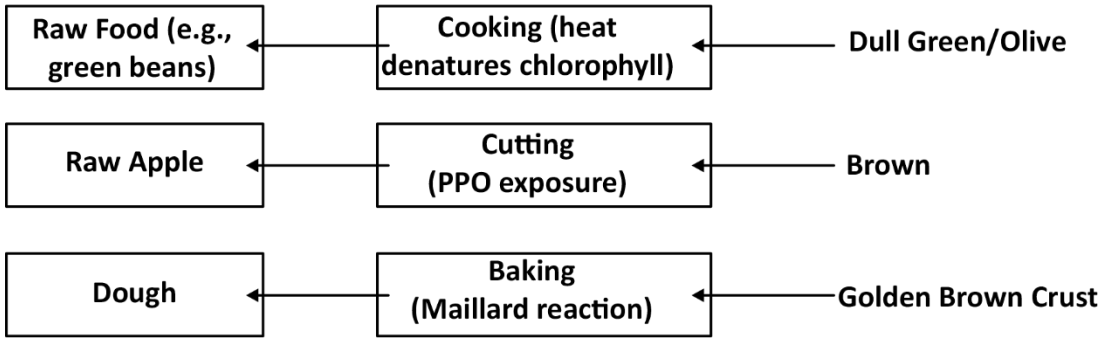
  Example: The vibrant orange of mangoes is due to beta - carotene, which may fade during overcooking.

Diagram 4: Color Changes in Food Processing

Description: A flowchart showing color changes:

- Raw Food (e.g., green beans) → Cooking (heat denatures chlorophyll) → Dull green/olive.
- Raw Apple → Cutting (polyphenol oxidase exposure) → Brown.
- Dough → Baking (Maillard reaction) → Golden brown crust.

Color Changes in Food Processing



2.2.3 Density and Specific Gravity

- **Density**: Mass per unit volume (g/cm³). Affects packaging and buoyancy.
  - High density: Nuts, dried fruits.
  - Low density: Ice cream (due to air incorporation, or overrun).
- **Specific Gravity**: Ratio of food density to water density (1 g/cm³). Used in beverages (e.g., milk, soft drinks).

  Example: Ice cream's low density (0.5–0.6 g/cm³) results from 30–50% air incorporation, creating a light, creamy texture.

2.2.4 Thermal Properties

- **Specific Heat**: Energy required to raise 1g of food by 1°C (J/g°C).
  - High: Water - rich foods (e.g., vegetables, ~4.18 J/g°C).
  - Low: Fats (e.g., oils, ~2.0 J/g°C).
- **Thermal Conductivity**: Rate of heat transfer (W/m•K).
  - High: Water - rich foods (e.g., soups).
  - Low: Porous foods (e.g., bread).
- **Thermal Diffusivity**: Heat distribution rate. Affects cooking uniformity.

Example: Frying oils have high thermal conductivity, enabling rapid cooking of foods like pakoras.

Table 7: Thermal Properties of Foods

Food	Specific Heat (J/g°C)	Thermal Conductivity (W/m•K)	Example Application
Water	4.18	0.6	Soups, boiling
Vegetable Oil	2.0	0.17	Frying
Bread	2.8	0.05	Baking
Meat (chicken)	2.7	0.5	Roasting, grilling

2.2.5 Rheological Properties

Rheology studies the flow and deformation of food materials:

- **Viscosity**: Resistance to flow (e.g., high in honey, low in water).
- **Elasticity**: Ability to return to shape (e.g., dough during kneading).
- **Plasticity**: Permanent deformation (e.g., butter spread).
- **Shear Thinning**: Viscosity decreases with stress (e.g., ketchup).
- **Shear Thickening**: Viscosity increases with stress (e.g., corn starch slurry).

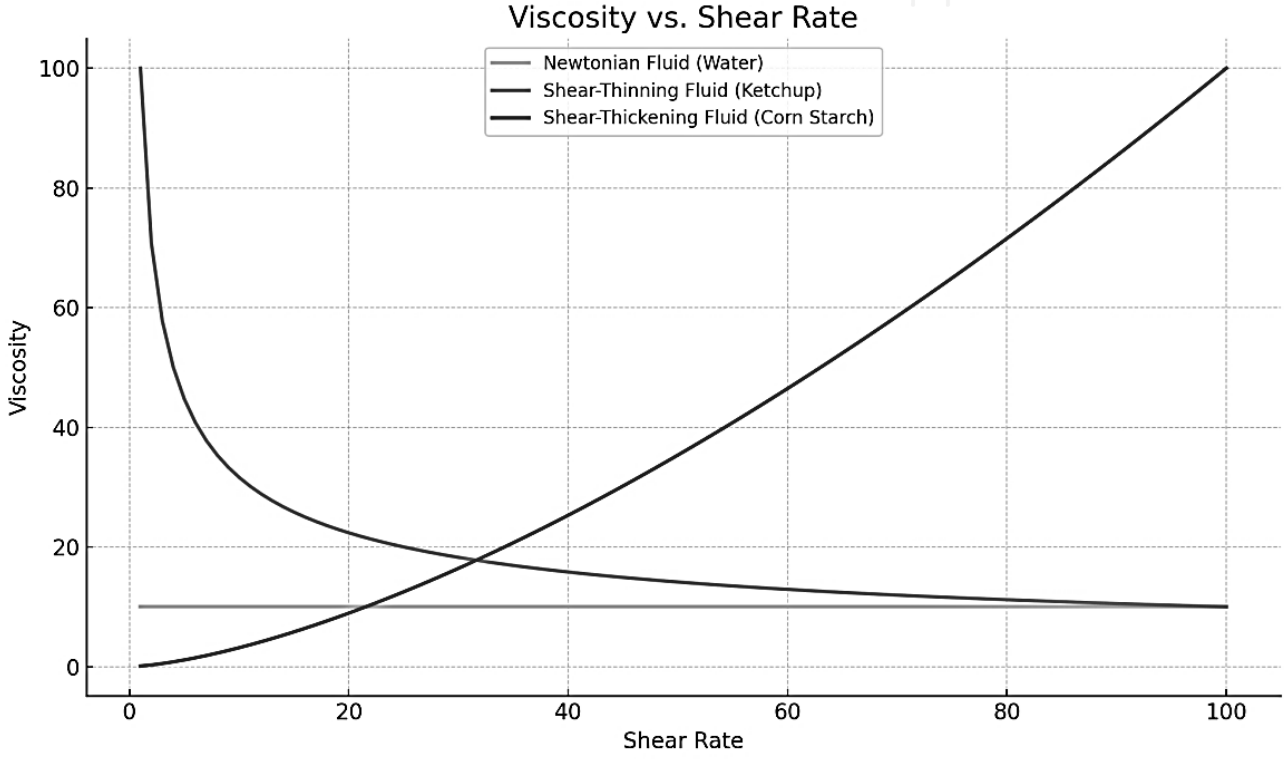
Measurement: Rheometers, viscometers.

Example: The stretchability of paneer is due to its elastic protein matrix, ideal for dishes like paneer tikka.

Graph 4: Viscosity vs. Shear Rate

Description: A line graph showing viscosity (Y - axis) vs. shear rate (X - axis) for:

- Newtonian fluid (e.g., water): Constant viscosity.
- Shear - thinning fluid (e.g., ketchup): Viscosity decreases.
- Shear - thickening fluid (e.g., corn starch): Viscosity increases.



2.3 Chemical Properties

2.3.1 pH and Acidity

- **pH**: Measures hydrogen ion concentration (0–14).
  - Acidic (pH < 4.6): Pickles, citrus fruits.
  - Low - acid (pH > 4.6): Vegetables, meat.
  - Neutral (pH ~7): Water, milk.
- **Titratable Acidity**: Total acid content, measured by titration with NaOH.
- **Impact**:
  - Microbial safety: Low pH inhibits pathogens (e.g., Clostridium botulinum).
  - Flavor: Acidity enhances tartness (e.g., tamarind chutney).
  - Enzyme activity: Optimal pH for enzymes (e.g., pectinase in fruit juices).

Example: Curd's pH (~4.0) results from lactic acid production, ensuring safety and tangy flavor.

Table 8: pH of Common Foods

Food	pH Range	Microbial Safety Implications
Lemon Juice	2.0–2.5	High safety (inhibits pathogens)
Curd	3.8–4.2	Safe, supports beneficial bacteria
Milk	6.5–6.7	Susceptible to spoilage
Spinach	5.5–6.8	Requires processing for safety
Meat (chicken)	5.7–6.4	High risk, needs cooking/refrigeration

2.3.2 Water Activity (a_w)

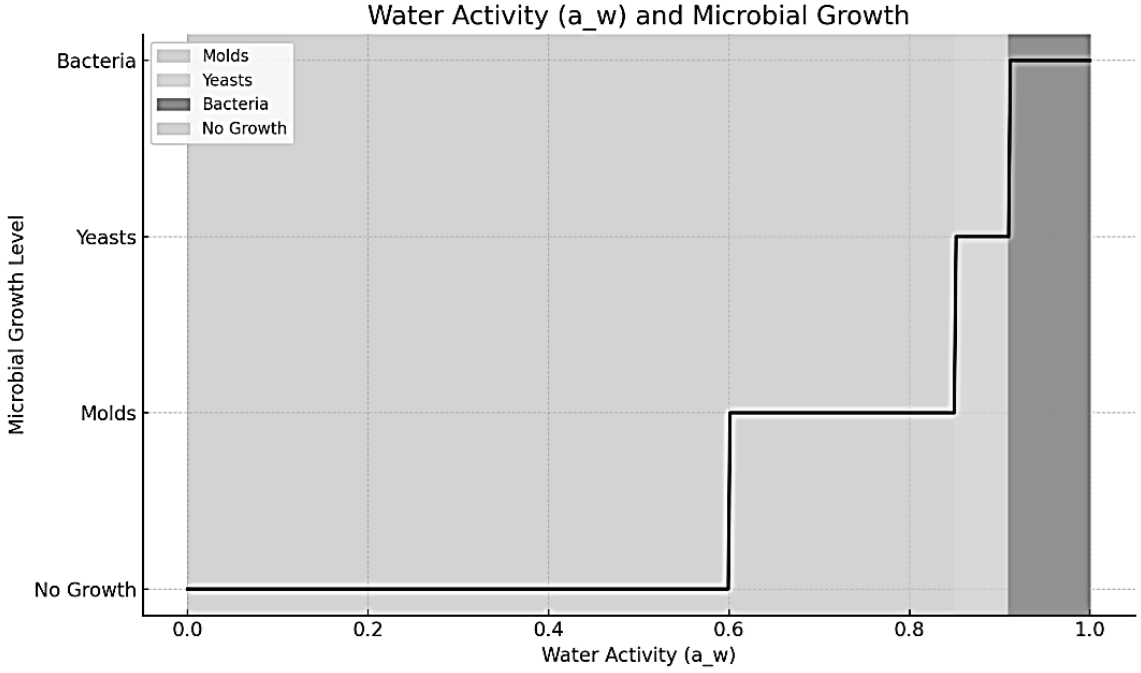
- **Definition**: Ratio of water vapor pressure in food to that of pure water (0–1).
  - High a_w (>0.85): Fresh fruits, vegetables, meat (prone to spoilage).
  - Intermediate a_w (0.6–0.85): Jams, cheese (limited microbial growth).
  - Low a_w (<0.6): Dried fruits, cereals, papad (shelf - stable).
- **Impact**:
  - Microbial growth: Pathogens require a_w >0.91; molds grow at a_w >0.6.
  - Texture: Low a_w creates crispiness (e.g., biscuits).
  - Shelf life: Reduced a_w extends stability.

Example: Chutneys have low a_w due to high sugar and salt, preventing spoilage.

Diagram 5: Water Activity and Microbial Growth

Description: A graph plotting microbial growth (Y - axis) vs. a_w (X - axis, 0–1). Key zones:

- a_w >0.91: Bacteria (Salmonella, E. coli).
- a_w 0.85–0.91: Yeasts.
- a_w 0.6–0.85: Molds.
- a_w <0.6: No microbial growth (e.g., dried spices).



2.3.3 Oxidative Stability

- **Definition**: Susceptibility of food components (lipids, vitamins) to oxidation, causing rancidity, off - flavors, and nutrient loss.
- **Types**:
  - **Hydrolytic Rancidity**: Lipase activity (e.g., in butter).
  - **Oxidative Rancidity**: Reaction with oxygen (e.g., in oils).
- **Factors**: Oxygen, light, heat, metal catalysts (e.g., iron).
- **Prevention**:
  - Antioxidants: Natural (vitamin E, rosemary extract), synthetic (BHA, BHT).
  - Packaging: Vacuum sealing, nitrogen flushing.

Example: Rancidity in groundnut oil results from lipid oxidation, producing a bitter taste.

2.3.4 Nutrient Content

- **Proximate Analysis**: Quantifies moisture, ash, protein, fat, carbohydrate, and fiber.
  - Moisture: Affects shelf life (e.g., high in fruits, low in grains).
  - Ash: Mineral content.
  - Protein: Kjeldahl method.
  - Fat: Soxhlet extraction.
  - Carbohydrate: By difference.
- **Micronutrient Analysis**: Spectroscopy (e.g., AAS for minerals), chromatography (e.g., HPLC for vitamins).

Example: Proximate analysis of atta shows 70% carbohydrates, 12% protein, 1% fat, and 10% moisture.

2.3.5 Enzymatic Activity

- **Definition**: Reactions catalyzed by enzymes, affecting quality.
- **Examples**:
  - **Polyphenol Oxidase (PPO)**: Causes browning in apples, bananas.
  - **Lipase**: Leads to rancidity in dairy (e.g., ghee).
  - **Amylase**: Starch breakdown in ripening fruits.
- **Control**:
  - Blanching: Inactivates enzymes (e.g., in frozen vegetables).
  - pH adjustment: Low pH inhibits PPO (e.g., lemon juice on cut fruits).
  - Heat treatment: Pasteurization denatures enzymes.

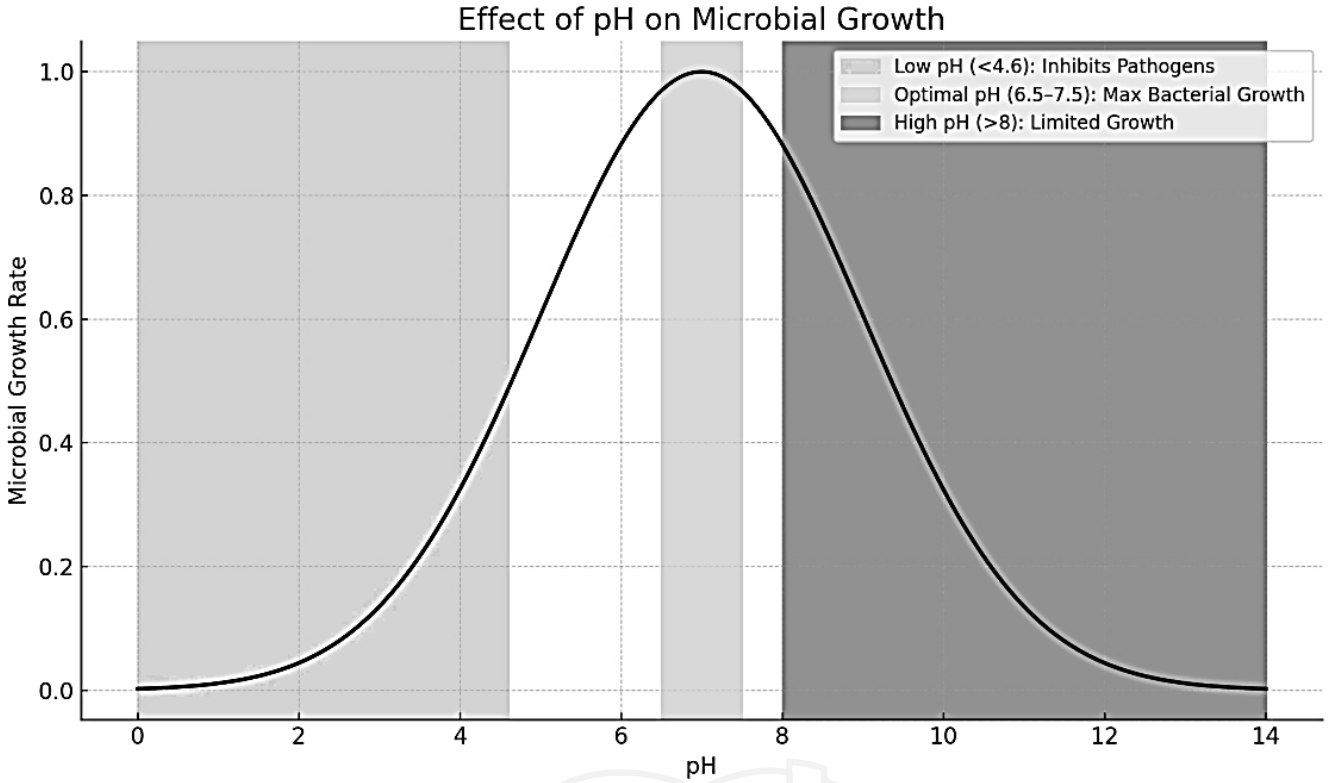
Table 9: Chemical Properties and Applications

Property	Description	Impact on Food	Example Food
pH	Acidity/alkalinity	Microbial safety, flavor	Curd, pickles
Water Activity	Available water for microbes	Shelf life, texture	Papad, jams
Oxidative Stability	Resistance to oxidation	Rancidity, nutrient loss	Oils, nuts
Nutrient Content	Macro/micronutrient levels	Nutritional quality	Atta, vegetables
Enzymatic Activity	Enzyme - catalyzed reactions	Browning, spoilage	Apples, ghee

Graph 5: Effect of pH on Microbial Growth

Description: A bell - shaped curve showing microbial growth rate (Y - axis) vs. pH (X - axis, 0–14). Key points:

- Optimal pH: 6.5–7.5 for most bacteria (e.g., E. coli).
- Low pH (<4.6): Inhibits pathogens (e.g., in curd).
- High pH (>8): Limited growth (e.g., in alkaline foods).



2.4 Applications of Physical and Chemical Properties

- **Food Processing**:
  - **Texture**: Extrusion for snacks (e.g., kurkure) relies on crispiness.
  - **pH**: Acidification in canning prevents botulism.
- **Quality Control**:
  - **Color**: Ensures consistency in processed foods (e.g., tomato ketchup).
  - **Water Activity**: Monitors stability in packaged goods (e.g., biscuits).
- **Product Development**:
  - **Rheology**: Designs emulsions (e.g., mayonnaise).
  - **Oxidative Stability**: Formulates antioxidant - enriched oils.
- **Safety**:
  - **pH and a_w**: Ensures microbial safety in pickles, jams.
  - **Enzymatic Control**: Blanching preserves color and texture in frozen peas.

Case Study: Development of a Shelf - Stable Mango Pickle

- **Physical Properties**:
  - Texture: Firm mango pieces achieved through proper cutting and vinegar addition.
  - Color: Vibrant yellow maintained by turmeric and minimal heat processing.
- **Chemical Properties**:
  - pH: Adjusted to <4.0 using vinegar to inhibit pathogens.
  - Water Activity: Reduced by adding salt and sugar (a_w <0.85).
  - Oxidative Stability: Mustard oil and spices act as natural antioxidants.
- **Outcome**: A safe, flavorful product with a 6 - month shelf life.

Sample PYQs:

June 2023:

Q. Which property determines microbial stability in dried foods?

(A) pH (B) Water activity

(C) Density (D) Color

Answer: (B) Water activity

Dec 2022:

Q. What causes enzymatic browning in cut apples?

(A) Lipase (B) Polyphenol oxidase
(C) Amylase (D) Pectinase

Answer: (B) Polyphenol oxidase

June 2021:

Q. Which property is critical for frying oils?

(A) Specific heat (B) Thermal conductivity
(C) Viscosity (D) pH

Answer: B) Thermal conductivity

Key Points for Revision

- **Food Science and Nutrition**:
  - Food science: Studies food composition, processing, and safety.
  - Nutrition: Focuses on nutrient roles in health.
  - Macronutrients: Carbohydrates (energy), proteins (growth), lipids (energy, membranes).
  - Micronutrients: Vitamins (metabolism, immunity), minerals (bones, oxygen transport).
  - RDA (ICMR): Guides nutrient intake (e.g., 2320 kcal for men, 1900 kcal for women).
  - Balanced diet: Includes all food groups, follows ICMR guidelines.
  - Public health nutrition: Addresses undernutrition, obesity via fortification, supplementation.
- **Properties of Food**:
  - **Physical**: Texture (hardness, viscosity), color (pigments, Maillard), density, thermal properties, rheology.
  - **Chemical**: pH (safety, flavor), water activity (shelf life), oxidative stability (rancidity), nutrient content, enzymatic activity.
  - Measurement: Texture analyzers, colorimeters, pH meters, rheometers.
  - Applications: Processing (e.g., frying), quality control (e.g., color consistency), safety (e.g., low pH).

Quality Evaluation of Foods – Objectives and Subjective

3.1 Introduction to Quality Evaluation

Quality evaluation of foods involves assessing the characteristics that determine a food's acceptability, safety, and compliance with standards. It encompasses sensory attributes (taste, texture, appearance), nutritional content, safety (microbial, chemical), and functional properties (e.g., shelf life, packaging integrity). Quality evaluation is critical in:

- **Food Industry**: Ensuring product consistency and consumer satisfaction.
- **Regulatory Compliance**: Meeting standards set by authorities like the Food Safety and Standards Authority of India (FSSAI).
- **Research**: Developing new products and improving existing ones.
- **Consumer Protection**: Preventing adulteration and ensuring nutritional claims.

Quality evaluation methods are broadly classified into:

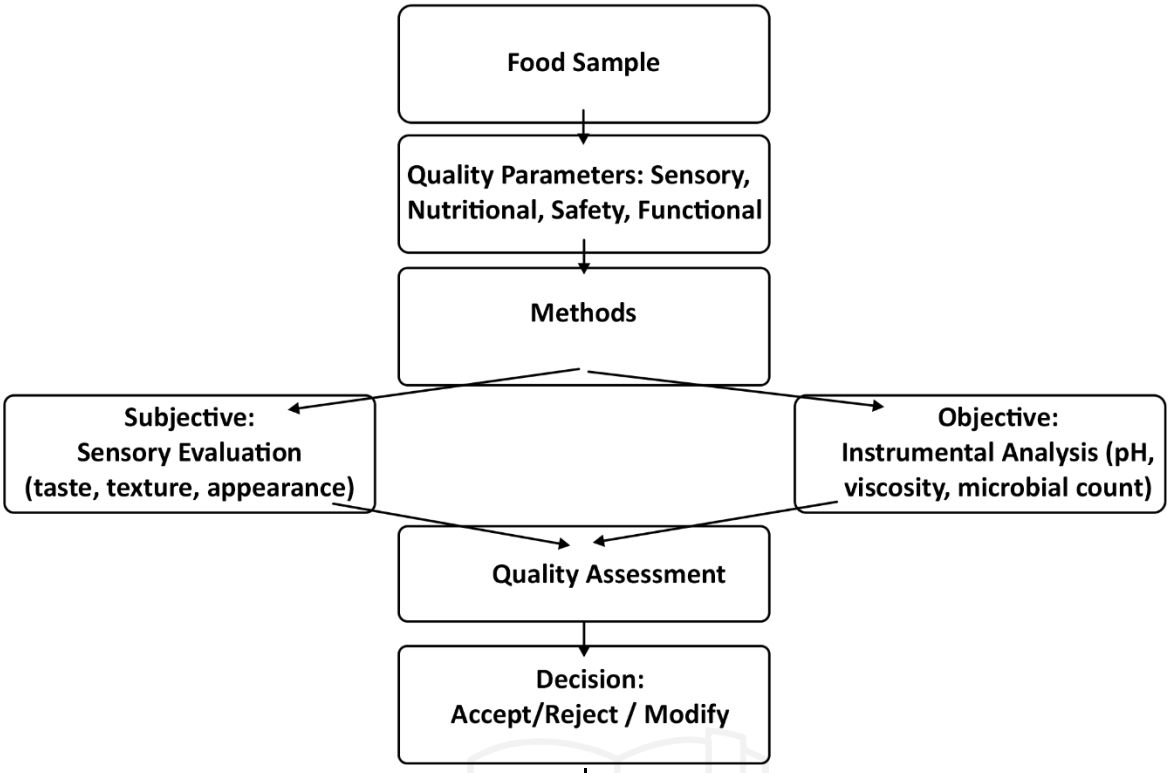
- **Subjective Methods**: Sensory evaluation, relying on human senses (taste, smell, sight, touch, hearing).
- **Objective Methods**: Instrumental or laboratory techniques, providing quantifiable data (e.g., texture analyzers, spectrophotometers).

Diagram 1: Framework of Food Quality Evaluation

Description: A flowchart outlining the quality evaluation process:

- Start: Food Sample → Quality Parameters (Sensory, Nutritional, Safety, Functional) → Methods:
  - Subjective: Sensory evaluation (taste, texture, appearance).
  - Objective: Instrumental analysis (pH, viscosity, microbial count).
- Outcome: Quality Assessment → Decision (Accept/Reject/Modify).

Framework of Food Quality Evaluation



3.2 Objectives of Quality Evaluation

The primary objectives of quality evaluation are to ensure food meets desired standards for safety, acceptability, and functionality. These objectives align with consumer expectations, industry needs, and regulatory requirements.

3.2.1 Ensure Consumer Satisfaction

- **Purpose**: Assess sensory attributes (taste, aroma, texture, appearance) to meet consumer preferences.
- **Example**: Evaluating the crunchiness of namkeen or the sweetness of gulab jamun to ensure appeal.
- **Relevance**: Sensory quality drives purchase decisions and brand loyalty.

3.2.2 Maintain Nutritional Quality

- **Purpose**: Verify nutrient content to meet dietary needs and labeling claims.
- **Example**: Measuring protein content in fortified atta to ensure compliance with FSSAI fortification standards.
- **Relevance**: Critical for public health nutrition, especially in addressing deficiencies (e.g., iron, vitamin A).

3.2.3 Ensure Safety

- **Purpose**: Detect contaminants (microbial, chemical, physical) to prevent health risks.
- **Example**: Testing milk for adulterants (e.g., urea) or pathogens (e.g., Salmonella).
- **Relevance**: Aligns with FSSAI's focus on food safety and HACCP principles (Sub - topic 6).

3.2.4 Standardize Product Quality

- **Purpose**: Ensure consistency across batches for uniform quality.
- **Example**: Checking color consistency in mango pulp for export markets.
- **Relevance**: Vital for industrial production and compliance with standards like ISO 22000.

3.2.5 Assess Shelf Life and Stability

- **Purpose**: Evaluate physical and chemical stability to determine storage duration.
- **Example**: Measuring oxidative rancidity in edible oils to estimate shelf life.
- **Relevance**: Links to food preservation and packaging (Sub - topics 4, 6).

3.2.6 Support New Product Development

- **Purpose**: Test prototypes for sensory and functional attributes.
- **Example**: Assessing consumer acceptance of a nano - encapsulated vitamin - fortified juice (Sub - topic 8).

- **Relevance**: Drives innovation in functional foods and nanotechnology.

3.2.7 Regulatory Compliance

- **Purpose**: Verify adherence to national and international standards.
- **Example**: Ensuring pesticide residues in vegetables are below Maximum Residue Limits (MRLs) set by FSSAI.
- **Relevance**: Prevents legal penalties and ensures market access.

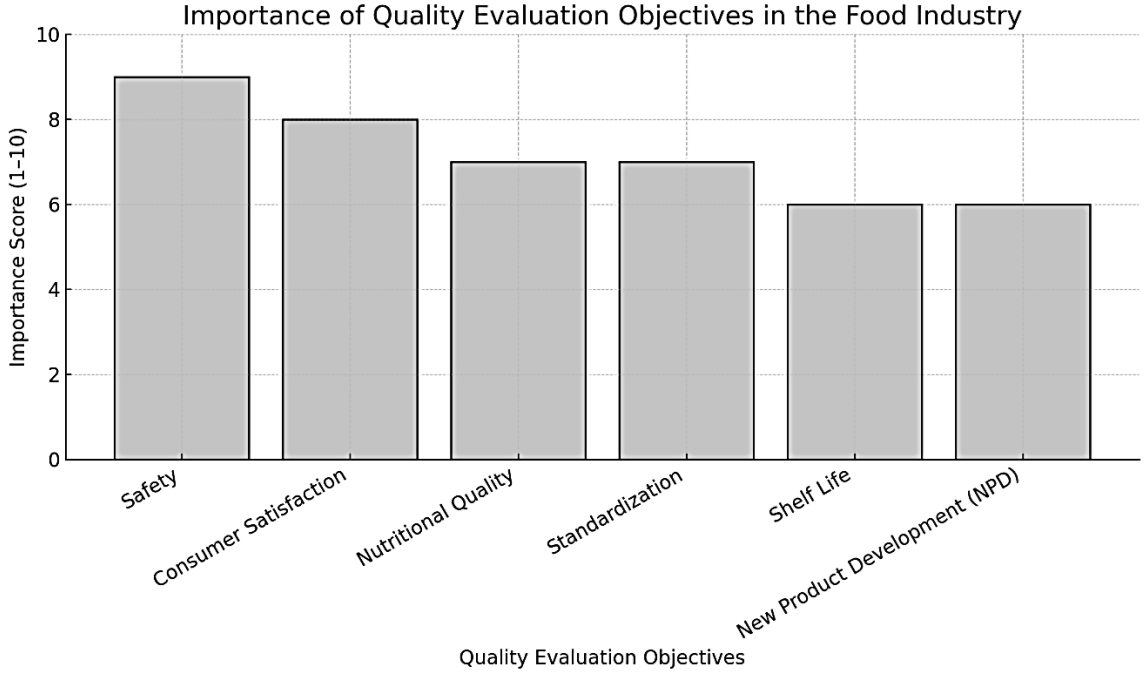
Table 1: Objectives of Quality Evaluation and Applications

Objective	Purpose	Example Application	Relevance to Unit - I
Consumer Satisfaction	Meet sensory expectations	Taste testing of masala chai	Links to food service (Sub - topic 7)
Nutritional Quality	Verify nutrient content	Protein analysis in dal	Links to nutrition (Sub - topic 1)
Safety	Detect contaminants	Microbial testing in paneer	Links to standards (Sub - topic 6)
Product Standardization	Ensure batch consistency	Color measurement in tomato ketchup	Links to properties (Sub - topic 2)
Shelf Life Assessment	Evaluate stability	Rancidity test in groundnut oil	Links to preservation (Sub - topic 4)
New Product Development	Test prototypes	Sensory evaluation of fortified snacks	Links to nanotechnology (Sub - topic 8)
Regulatory Compliance	Meet standards	Pesticide residue test in rice	Links to HACCP (Sub - topic 6)

Graph 1: Importance of Quality Evaluation Objectives

Description: A bar graph comparing the relative importance of quality evaluation objectives in the food industry. X - axis: Objectives (Consumer Satisfaction, Nutritional Quality, Safety, etc.). Y - axis: Importance Score (1–10, based on industry surveys). Observations:

- Safety: Highest score (9), due to health risks.
- Consumer Satisfaction: High score (8), drives sales.
- Nutritional Quality and Standardization: Moderate (7), critical for labeling and consistency.
- Shelf Life and NPD: Slightly lower (6), but growing with innovation.



3.3 Subjective Methods: Sensory Evaluation

Sensory evaluation is the scientific discipline of measuring and analyzing food characteristics using human senses—taste, smell, sight, touch, and hearing. It is subjective because it relies on human perception, which varies based on individual preferences, cultural background, and training. Sensory evaluation is essential for:

- Assessing consumer acceptability.
- Developing new products with desired sensory profiles.
- Ensuring consistency in sensory quality.

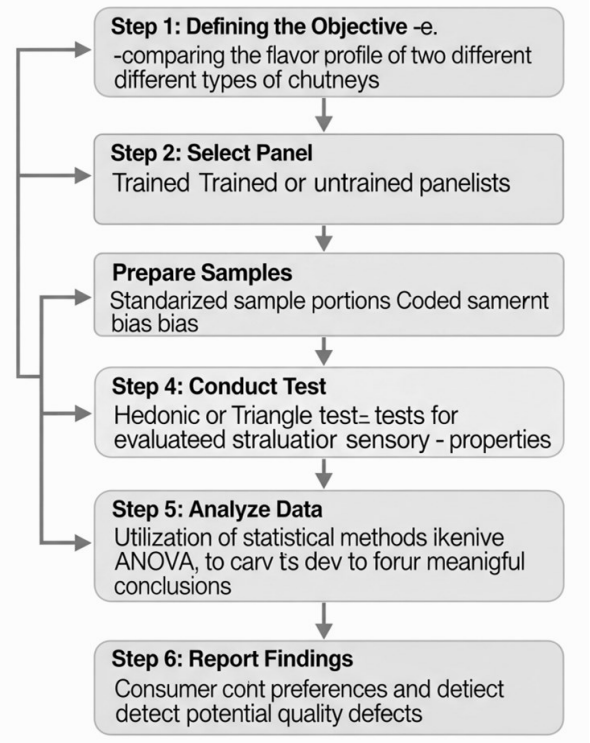
3.3.1 Principles of Sensory Evaluation

- **Controlled Environment**: Conducted in sensory booths with controlled lighting, temperature, and noise to minimize bias.
- **Trained Panels**: Use trained or semi - trained panelists for objective assessments, or untrained consumers for preference tests.
- **Standardized Procedures**: Follow protocols (e.g., ISO 8586 for panel training) to ensure reliability.
- **Ethical Considerations**: Obtain informed consent, ensure no health risks (e.g., allergies).

Diagram 2: Sensory Evaluation Process

Description: A flowchart depicting the sensory evaluation process:

- Step 1: Define Objective (e.g., compare flavors of two chutneys).
- Step 2: Select Panel (trained/untrained).
- Step 3: Prepare Samples (standardized portions, coded to avoid bias).
- Step 4: Conduct Test (e.g., hedonic test, triangle test).
- Step 5: Analyze Data (statistical methods like ANOVA).
- Step 6: Report Findings (e.g., consumer preference, quality defects).



3.3.2 Types of Sensory Tests

Sensory tests are categorized based on their purpose: discrimination, descriptive, or affective.

3.3.2.1 Discrimination Tests

- **Purpose**: Detect differences between samples.
- **Examples**:
  - **Triangle Test**: Panelists identify the odd sample among three (two identical, one different). Used to detect subtle differences (e.g., reformulated biscuits).
  - **Duo - Trio Test**: Panelists match a test sample to one of two reference samples. Used in quality control (e.g., ghee consistency).
  - **Paired Comparison Test**: Panelists determine which of two samples has a specific attribute (e.g., sweeter syrup).
- **Application**: Ensures batch consistency, detects formulation changes.

3.3.2.2 Descriptive Tests

- **Purpose**: Quantify sensory attributes (intensity of flavor, texture, etc.).
- **Examples**:
  - **Quantitative Descriptive Analysis (QDA)**: Trained panelists rate attributes on a scale (e.g., 0–15 for spiciness of curry). Produces sensory profiles.