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Salahaddin University-Erbil

On Some Mathematical Applications In Nutrition And Food Science

Research Project

Submitted to the department of (Mathematic) in partial fulfillment of the requirements for the degree of BSc. in (forth)

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Certification of the Supervisor

I certify that this report was prepared under my supervision at the Department of Mathematics / College of Education / Salahaddin University-Erbil in partial fulfillment of the requirements for the degree of Bachelor of philosophy of Science in Mathematics.

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In view of the available recommendations, I forward this report for debate by the examining committee.

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Abstract

In this work we study some mathematical applications in nutrition and food science. First, we give basic definitions and fundamentals of foods, nutrition and diet therapy. Then, we study Modeling of food and food process. In addition, we study the most representative value of continuous data and nutrient density. Furthermore, we study Mathematical modeling of gastric emptying and nutrient absorption in the human digestive system and, Observations on the use of statistical methods in food science and technology, In all applications we solve many examples that illustrate the applications.

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INTRODUCTION

Nutrition and food science frequently use mathematical modeling and analysis to comprehend intricate biological and chemical processes. In addition to expanding our knowledge of dietary needs and food composition, the use of mathematical principles in these fields helps create novel food products and approaches to better human health. In this work we illustrate the adaptability and significance of mathematical methods in tackling the varied issues confronted by nutritionists and food scientists and we cover subjects including food composition analysis, quantitative modeling of metabolic processes, and dietary intervention optimization. We hope to promote a greater understanding of the role that mathematics plays in expanding our knowledge of the intricate relationships between food, nutrition, and human health by emphasizing the relevance of mathematical applications in nutrition and food science. Applied issues in food science have led to significant advances in statistics. Classic instances are the "lady tasting tea" experiment and the connection between Guinness and the t-test. (Pripp, 2013), (Mudambai S.R, 2007)

This work consists of three chapters and is organized as follows. In chapter one we give basic definitions and fundamentals of foods, nutrition and diet therapy. In Chapter two we study statistics in food science and nutrition. At the last chapter, we study mathematical modeling of gastric emptying and nutrient absorption in the human digestive system, observations on the use of statistical methods in food Science and technology, procedures for Estimating Nutrient Values for Food Composition Databases. Furthermore, we study the modeling of the microbial quality of food. food and nutrition are filled with the thrill of data and statistics in addition to cuisine, culture, and healthy living. In addition, we solve many examples that illustrate the applications.

Chapter One

Fundamentals of foods, nutrition and diet therapy

The body gets its nourishment from food. Food can also be described as anything consumed that satisfies the body's demands for constructing, regulating, protecting, and energizing. Simply put, food is the building block of our bodies. Eating the correct foods in the right proportions will guarantee optimal nutrition and health, which can be shown in our looks, productivity, and emotional stability. Food ingredients are naturally nonhomogeneous and highly complicated.

1.1 Food and functions of food (Mudambai S.R, 2007)

The body gets its nourishment from food. Food can also be described as anything consumed that satisfies the body's demands for constructing, regulating, protecting, and energizing. Simply put, food is the building block of our bodies. Eating the correct foods in the right proportions will guarantee optimal nutrition and health, which can be shown in our looks, productivity, and emotional stability. The definition of nutrition is food at work in the body. Everything that occurs to food from the moment it is consumed until it is utilized by the body for different purposes is referred to as nutrition. Food ingredients known as nutrients are those that the body need in sufficient levels to support growth, reproduction, and a normal, healthy life. Water, proteins, lipids, and carbs are examples of nutrients. vitamin and mineral content. Since each of the groupings contains many nutrients proteins, lipids, carbs, minerals, and vitamins the terms have been used in their plural forms. Therefore, food provides more than 40 important nutrients that are needed to make literally thousands of other compounds that are required for physical fitness and survival. Nutrition science studies the kinds of nutrients our bodies require, how much we need, why we need them, and where to get them. The types of foods that the body receives and the ways in which it processes those foods combine to form nutrition The terms "adequate," "optimum," and "good nutrition" denote the proper amount and proportion of the required nutrients being supplied. A person's nutritional state can be fair, poor, or good. An attentive, kind disposition, a well-developed body with a typical weight for height, firm, well-developed muscles, healthy skin, and reddish-pink eyelid and mouth membrane color are all signs of adequate nutritional status. healthy subcutaneous fat layer, lustrous, smooth hair, clear eyes, strong appetite, and outstanding overall health. A poor nutritional status can be caused by eating the wrong foods, eating irregularly, working, sleeping, and eliminating waste. "State of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" is how the World Health Organization (WHO) defines health. malnutrition is defined as an unfavorable kind of nutrition that results in illness. It is caused by an imbalance, excess, or deficiency of certain nutrients in the diet.

The oxidation of the meal is what provides the energy required. The stuff we eat integrates into who we are. Building the body is hence one of food's most crucial purposes. If an infant weighs 2.7–3.2 kg at birth and consumes the correct kinds and quantities of food throughout their adult life, they can reach their full adult size of 50–60 kg. Daily eating contributes to the replacement of the body's worn-out cells and preserves the structure of the adult body.

Food has always played a major role in our social lives. It has been a part of our social, cultural, religious, and community lives. At particular life milestones, such as birth, naming ceremonies, birthdays, marriages, etc., feasts are held. The majority of religious celebrations also involve feasts and feedings of particular population groups. (Mudambai S.R, 2007)

Functions of Nutrients:

We consume rice, wheat, dal, fruits, vegetables, dairy products, eggs, fish, meat, sugar, butter, oils, and so on every day. Nutrients are various chemical components that make up these various foods. These are categorized based on the chemicals that make them up. Although each class of nutrients has a specific purpose, for optimal action, the different nutrients must work together. Foods contain the following nutrients: water, minerals, vitamins, proteins, fats, and carbs. Another crucial element of our diet is fiber. The following lists the roles that nutrients play carbs: Examples of carbs in diet include fruit and sugarcane, as well as starch found in grains. Carbs are primarily used by our bodies to produce the energy that they require. If not used right away, they are either stored as glycogen or transformed into fat and kept in reserve to be released when needed as a source of energy. Fats also include important fatty acids and fat-soluble vitamins. If too much fat is consumed through diet, the body will store it as fat reserves. Fat is stored in the body when energy intake exceeds necessary bodily functions. Proteins: Some examples of proteins found in diet are casein from milk, albumin in eggs, globulins in legumes, and gluten in wheat. Building new tissues as well as preserving and repairing existing ones is the primary role of proteins. The synthesis of hormones, antibodies, and other regulatory and protective chemicals is another way that dietary proteins work. The proteins in the diet provide about 10% of the total energy. When more protein is consumed than the body needs, it is transformed into fats and carbs and stored in the body. Minerals: Numerous foods contain both organic and inorganic components together with the minerals calcium, phosphorus, iron, iodine, salt, potassium, and others. Building bones, teeth, and the structural components of soft tissues all require minerals, which are also important for body building. Foods contain water-soluble vitamins C and B group as well as fat-soluble vitamins A, D, E, and K. These are necessary for development, healthy bodily functions, and regular bodily functions. A large portion of the water we consume comes from the food and drinks we consume. About 60% of our body weight is made up of water, which is a crucial component of our bodily composition. Water is necessary for the body to utilize food materials and to get rid of food waste. It controls bodily functions like maintaining body temperature. (Mudambai S.R, 2007)

1.2 Modeling of Food and Food Process:

Capturing the key mechanisms during food processing is the primary goal of modeling, with the foundation being current theory and data. Several factors include the model's structural design, which includes the variable to be selected, the nature of the relationship, and the calculation's capacity to be verified through an identification test of the structure's design. Because of advancements in computer technology, the physics-based models of the present generation are getting more realistic by adding more complex physics. improving the scope and use of modeling in research, product, process, and equipment design by making it more user-friendly. Physics-based models have not yet been constructed for food quality and safety since correlations between food quality, food safety, and process factors are not available in these models. Since physical processes are not needed in observational models. The majority of fluid mechanics issues in the food industry are resolved through modeling that applies Newton's equations of motion to fluids (Zinger, 2017).

Understanding Nutrition Fact Labels 1.3

A Cheerios box says that one cup (28 grams) of Cheerios contains 190 milligrams of sodium which it claims is 8% of the recommended maximum daily allowance of sodium (Zinger, 2017).

Example1.1. The recommended daily allowance of sodium is 2400 milligrams. Should you believe the claim on the box?

Solution: We are asked to find what percentage is 190 of 2400. Let the percentage be x and use the percentage equation $\frac{is}{of} = \frac{percent}{100}$. Then $\frac{190}{2400} = \frac{\mathrm{x}}{100}$. Simplify the right-hand side by dividing numerator and denominator by 10 $\frac{19}{240} = \frac{x}{100}$. Then x = 190 ÷ 24 = 7.9166, so x ≈ 8 and so one cup of Cheerios contains approximately 8% of the daily allowance of sodium.

Example 1.2. How many milligrams of sodium are there in 2 cups of Cheerios?

Solution: There are 2×190 = 380 milligrams of sodium in two cups of Cheerios.

Example 1.3. Find a formula, which describes how many milligrams of sodium there are in x cups of Cheerios.

Solution: Let y be the number of milligrams then there are y = 190x milligrams of sodium in x cups of Cheerios. This is a linear function.

Example 1.4. How many milligrams of sodium are there in 4⁄5 cups of Cheerios?

Solution: y = 190 · $\frac{190}{1}$. $\frac{4}{5}$ = 152 milligrams of sodium in 4⁄5 cups of Cheerios.

Example 1.5.A box of Cheerios contains 14 cups in total. How many milligrams of sodium are there in the whole box?

Solution: y = 190 · 14 = 2660 milligrams of sodium.

Example 1.6. From the above you see that a box of Cheerios contains more than the daily allowance of 2400 milligrams of sodium. How many cups of Cheerios make up the entire daily allowance?

Solution: We are given the amount of sodium y=2400, and need to find the number of cups x. Substitute 2400=190x. Divide through by $\frac{2400}{190} = \mathrm{x}$ Then x=$\frac{240}{19} \approx$ 12.6 cups of cheerios contain the maximum daily allowance of sodium.

Example 1.7. There are 15 calories from fat in a cup of Cheerios, and 10 calories from fat in a cup of skim milk. The total number of calories t in c cups of Cheerios and m cups of skim milk is described by the literal equation t = 15c + 10m

a. Solve this literal equation for m

b. If your bowl of cereal has 50 Kcal of fat and includes 2 cups of Cheerios, then how many cups of milk did you use?

Solution: a) We have to isolate m, so first subtract 15c from both sides

t – 15c = 10m Then divide both sides by 10 $\frac{t-15c}{10} = \mathrm{m}$

b) Substitute t = 50 and c = 2 $\frac{50-15.2}{10} = m$, simplify the numerator $\frac{20}{10} = m$

Then divide, so you had 2 cups of skim milk.

Chapter Two

Statistics in Food Science and Nutrition

Food and nutrition are filled with the thrill of data and statistics in addition to cuisine, culture, and healthy living. Applied issues in food science have led to significant advances in statistics. A foundational understanding of statistical analysis and study design is essential, Strict statistical jargon says that multivariate statistics is different from univariate methods because it analyzes many outcome (dependent) variables simultaneously. Particularly, when examining the connections between lifestyle, health, and eating habits. Maybe you like to check the food labels on products at the grocery store to find out how much protein, fat, and carbs are there, along with other nutritional information. Sales data on various food types and expiration dates piques the interest of consumers. There is more to the topic of food and nutrition than just customs, culture, cuisine, and healthy living. It is also filled with the satisfaction of gathering and evaluating data from pre-existing databases, conducting customer interviews, or creating it in a lab. In quantitative research, pertinent data must be gathered and analyzed. Scientific theory, reasoning, and conclusions are heavily reliant on data interpretation. The evaluation of information from physical, microbiological, chemical, sensory, and commercial analyses completes the field of food science and nutrition. Research on food and nutrition is heavily reliant on quantitative data, making statistics a fundamental component of this multidisciplinary field. Descriptive statistics and statistical testing are the two subfields of statistics that can be separated from an extremely applied perspective.

2.1 The Most Representative Value of Continuous Data

Example2.1: Let us examine again the pH measurements of our ten yogurt samples. Remember, we have missing data for sample 4; therefore, we have only nine data observations. Reordering the pH data in ascending yields 4.15, 4.21, 4.22, 4.22, 4.31, 4.35, 4.38,

Table of Comparison of two categorical variable

	Low-fat yogurt	Full-fat yogurt	Total
Men	12 (30%)	28 (70%)	40 (100%)
Women	45 (75%)	15 (25%)	60 (100%)
Total	60 (60%)	40 (40%)	100 (100%)

4.41, and 6.41. What single number represents the most typical value in this data set? For continuous data, the most "typical" value, or what is referred to in statistics as the central location, is usually given as either the mean or median. The mean is the sum of values divided by the number of values (the mean is also known as the "standard" average). It is de fined for a given variable X with n observations as: $\bar{X}=\frac{1}{n}\sum_{i=1}^{n} xi$ and is estimated in our example as

$$mean=\frac{4.15+4.21+4.22+4.22+4.31+4.35+4.38+4.41+6.41}{9}=4.52$$

The single outlier measurement of pH 6.41 has a relatively large in fluence on the estimated mean. An alternative to the mean could be to use the median. The median is the numeric values separating the upper half of the sample or, in other words, the value in the middle of our data set. The median is found by ranking all the observations from lowest to highest value and then picking the middle one. If there is an even number of observations and thus no single middle value, then the median is de fined as the mean of the two middle values. In our example the middle value is 4.31. A rather informal approach to deciding whether to use the mean or median for continuous data is to estimate them both. If the median is close to the mean, then one can usually use the mean, but if they are substantially different, then the median is usually the better choice (Pripp, 2013).

2.2 Spread and Variation of Continuous Data

Telling half the story means describing the most usual value or the primary location. It's also necessary to explain how the statistics vary or spread out. It is customary to utilize the standard deviation, or only the maximum and lowest values, for continuous data. Compared to the mean and median, these may not be as intuitive. The standard deviation is frequently used when a data collection lacks extreme outliers or a so-called skewed distribution—that is, when there are a lot of values that are extremely high or low in comparison to the rest of the data. It may be an approximation. Standard deviation (SD)= $\sqrt{\frac{\sum_{i=1}^{n}(\mathrm{xi}-\bar{x})^2}{n-1}}$

If we exclude the extreme pH value in sample 10 (regarded as an outlier), then the new mean of our remaining eight data points on pH is estimated to be 4.28 and the standard deviation is estimated as $SD = \sqrt{\frac{(4.41-4.28)^2+(4.21-4.28)^2+\cdots+(4.22-4.28)^2}{8-1}} = 0.09$

Thankfully, most statistical software and spreadsheets, including Excel and OpenOffice, can estimate standard deviations and other statistics effectively, negating the need to understand precise computation methods and estimates formulas. A distance of one standard deviation from the mean will contain roughly 65% of our data, assuming that our data are roughly normally distributed. We can find that almost 95% of our data fall within two standard deviations from the mean. The mean and standard deviation are frequently used to characterize continuous data because of this primary reason. It is more typical to characterize a data set as the median, with the minimum and maximum values representing the spread, if the data set has a skewed distribution or contains a large number of outliers or extreme values. The so-called interquartile range is an alternate way to quantify data distribution that lessens the impact of extreme results. The difference between the third and first quartiles is its equivalent. By placing each observation in ascending order, it may be located. To keep things simple, let's say that each person has 100 observations. If the observations are arranged in ascending order, the lower boundary of the interquartile range is located at the border of the first 25% of the observations, or observation 25 in this case.

If the observations are arranged in ascending order, the upper boundary of the interquartile range is located at the edge of the first 75% of the data, or observation 75 in this case. (Pripp, 2013)

2.3 Nutrient Density

A balanced diet includes more than simply the recommended amount of calories because our bodies need a variety of nutrients for proper growth, development, and health, such as vitamins, minerals, protein, fiber, and vital fatty acids. To maintain a healthy weight and lower our risk of developing certain non-communicable diseases, the majority of dietary guidelines actually advise us to eat a lot of "nutrient dense" foods. Understanding the composition of foods and how the ideas of energy content and nutrient density relate to one another in our diets can be a first step towards improving our diet choices at a time when meals can easily deliver excessive energy without meeting the recommended nutrient levels (Drewnowski, 2018)

What is nutrient density and why is it important?

Foods with comparable calorie counts might differ greatly in the nutrients they offer. Just picture a scoop of vanilla ice cream with a medium orange. Even when offered in portions with equal calorie counts, the amounts of added sugars, fiber, vitamins, and fats vary greatly. Foods with different nutritional compositions can exist even within the same dietary group. For instance, wholegrain varieties of rice, pasta, and bread typically have more fiber, vitamin, and mineral contents than refined varieties. In a similar vein, Lean meat cuts that are fresh typically have lower fat and salt content than comparable quantities of processed meats like sausages or bacon. We typically refer to a food as "more nutrient dense" when it contains a higher concentration of vital elements per calorie. Key nutrients include those that humans often consume in less quantities than those advised, such as protein, unsaturated fats, fiber, and certain vitamins and minerals (such as calcium, iron, iodine, vitamin D, potassium, and folate). The fundamental tenet of any healthy diet is to consume "nutrient-dense foods," which you may recognize from official dietary guidelines. Diets centered around nutrient-dense meals reduce the likelihood of consuming excess calories, saturated fat, cholesterol, and sugar. alcohol or salt (sodium) and are more likely to maintain a healthy weight and lower their chance of contracting specific illnesses.2. On the other hand, we run the risk of reaching or even exceeding our energy needs without obtaining adequate micronutrients or other health-promoting substances if we consistently consume meals that are high in calories but low in vitamins and minerals.3. This raises our chance of developing certain non-communicable diseases and nutritional deficiencies over time. First, let's clarify the distinction between nutrient density and energy. (Drewnowski, 2018)

What is the difference between energy density and nutrient density?

The number of calories in 100 grams of food is known as energy density, and it is a straightforward way to quantify how much energy a particular food item has. To put it simply, we will consume more calories when compared to the same portion of low energy-dense foods since high energy-dense foods have more energy per gram of food. The amount of water (0 kcal/g), carbs (4 kcal/g), protein (4 kcal/g), fats (9 kcal/g), and alcohol (7 kcal/g) that a food or beverage contains determines its energy density. Because of this, foods that are high in energy tend to be dry and heavy in fat (biscuits, chips, candy, butter, etc.). Nutrient profiling techniques, which we'll discuss below, are used to determine a food's nutrient density, which is the proportion of nutrients per calorie. These days, meals that are low in saturated fats, added sugars, and sodium and higher in nutrients that support health per calorie are referred to as "nutrient-dense foods."2. Although the ideas of energy and nutrient density aid in our understanding of food composition, it's crucial to remember that other elements, such as frequency of consumption or portion sizes, can affect the quantity and quality of calories and nutrients we receive from food. The term "energy density" simply describes how many calories there are in 100 grams of food. To put it simply, we will consume more calories when compared to the same portion of low energy-dense foods since high energy-dense foods have more energy per gram of food The amount of water (0 kcal/g), carbs (4 kcal/g), protein (4 kcal/g), fats (9 kcal/g), and alcohol (7 kcal/g) that a food or beverage contains determines its energy density. That's why foods high in fat and/or dry (biscuits, chips, sweets, butter, etc.) are typically associated with energy density, whereas those low in fat and/or water (vegetable soups, fruits, veggies, etc.) are associated with lower energy density. Nutrient density cannot be characterized with the same objectivity as energy density Nutrient profiling techniques, which we'll discuss below, are used to determine a food's nutrient density, which is the proportion of nutrients per calorie. These days, meals that are low in saturated fats, added sugars, and sodium and higher in nutrients that support health per calorie are referred to as "nutrient-dense foods. "Although the ideas of energy and nutrient density aid in our understanding of food composition, it's crucial to remember that other elements, such as frequency of consumption or portion sizes, can affect the quantity and quality of calories and nutrients we receive from food. (Drewnowski, 2018)

How is the nutrient density of foods calculated

Nutrient profiling techniques are what determine a food's nutrient density. These techniques calculate a food's particular nutritional content (per 100g, 100 kcal, or serving) and then score it by comparing it to the recommended daily intake. By classifying foods (as well as meals or diets) according to their nutritional value, nutrient-rich foods can be distinguished from those that are primarily high in energy or have poorer nutritional value. Thus, their goal is to assist in identifying foods that are more likely to be found in a healthy diet as well as those that may specifically lead to an excessive intake of energy. salt, sugar, trans fats, or saturated fats. Broadly speaking, foods high in nutrients that we should eat in moderation, like saturated fats, added sugars, and sodium (salt), score lower than foods that provide significant amounts of health-promoting nutrients that are typically not consumed enough, like fiber, unsaturated fatty acids, potassium, calcium, iron, iodine, and vitamin D. The applications of nutrient profiling techniques are numerous. They are frequently used to create front-of-pack labeling strategies that help distinguish between items that have a better nutritional balance than others by using color-coded labels or visual cues. They can also assist in informing governmental decisions about things like limiting children's access to advertisements for less healthful foods, controlling food claims made about nutrition, or pushing the food sector to reformulate its offerings. They still have certain restrictions, though. Most importantly, several approaches consider various nutrients and standards for evaluation. For instance, some people might only classify a food as being higher in nutrients if it has lower concentrations of nutrients that are advised to be limited, like added sugars, saturated fat, and sodium. Others, on the other hand, base their score on the food's significant contributions of nutrients that promote health, like fiber or vitamin D, even though it may have relatively high concentrations of some of the limiting nutrients. (Drewnowski, 2018)

2.4 Comparison of Harris Bendict and Mifflin-St Jeor Equations :

The quantity of energy that the human body utilizes at rest is known as the basal metabolic rate. It is the quantity of energy required by your body to sustain life's essential processes, such as breathing, blood circulation, temperature regulation, and brain and nerve activity. The brain, central nervous system, and liver are the organs that consume the most energy when they are at rest. It's interesting to note that during the day, maintaining fluid volumes and ion levels uses more energy than the actual mechanical labor of contracting muscles When it comes to breathing, for example, we automatically adjust the concentrations and amounts of different substances in different parts of our body to maintain homeostasis (a state of steady internal conditions). This sometimes involves moving substances through barriers (like cell membranes) and against a gradient in concentration (or molarity), which means that particles are moved from space, where they are at a low concentration, to space, where they are at a higher concentration – a process that requires energy. It also clarifies why, in terms of basal metabolic rate, our central nervous system uses so much energy. Numerous distinct ions move to different locations in response to a neuronal impulse. They then have to be returned to their original location Humans frequently consume more energy than they burn during rest. The reason for this is that most individuals don't stay in bed all day! Physical activities such as walking, running, working, talking, and even digesting use more energy than the body uses at rest. You must be both psychologically and physically passive to attain such a low energy expenditure. Other prerequisites include fasting for a predetermined amount of time and remaining in a thermally comfortable area. The latter guarantee that digestion of food won't require energy use. BMR is frequently assessed in a laboratory environment while the subject is sleeping Your BMR makes up between 60% and 75% of your total energy expenditure (TEE), based on your activity level and lifestyle. The remainder of your TEE is derived from food digestion and physical activity including eating, talking, and walking. Approximately 20% of your overall energy expenditure comes from physical activity, though this can vary slightly based on how frequently and how intensely you exercise. Roughly 10% of your TEE is used up by food digestion, or as some refer to it, postprandial (after-meal) thermogenesis. BMR often declines as one ages and as one's lean body mass decreases. However, growing your muscular mass will probably result in a higher BMR.

How to use the basal metabolic rate calculator:

The abbreviation for basal metabolic rate is BMR. Everybody's body goes through a series of chemical processes known as basal metabolism, which keep it in a live state. This subject was fully discussed in the paragraph before (What is BMR? – BMR definition). By calculating your basal metabolic rate, you may determine how few calories you require to survive and, consequently, how many total calories you should give your body each day. Recall that

You need to double the number of calories our BMR calculator gives you by the amount of energy you expend (in calories) on other activities, such as walking, talking, etc. You can calculate your daily total energy expenditure by adding an additional 10% for digestion. Start by taking a weight reading and entering it into our calculator's Weight field. Next, measure yourself and enter your height in the Height field.Please enter your age in the Age field now. Note that the age value must be expressed in years. 6.Choosing your sex is the final step. You will see how it modifies the basal metabolic rate formula slightly in the following section. Your minimal calorie intake will now be displayed by our basal metabolic rate calculator if you have correctly completed all the procedures. (Amirkalali, 2008)

How to calculate BMR – the BMR formula:

The BMR can be calculated using a variety of formulas. We utilized the Mifflin-St. Jeor equation in this calculator since it is currently thought to produce the most accurate result. The following is the BMR formula:

Weight (kg) + height (cm) – age (y) + s (kcal/day) equals BMR (kcal/day), where s is +5 for men and -161 for women. We also have calculators that use different formulas to calculate your basal metabolic rate. The Harris-Benedict equation was the most widely used method for determining basal metabolic rate for a very long time. For more than 70 years after its initial publication in 1919, it was regarded as the most accurate formula for basal metabolic rate. Later, the Mifflin St. Jeor Equation another basal metabolic rate calculation that proved to be even more accurate took its place. The Harris-Benedict Equation is still used by a large number of BMR calculators, however it is gradually being supplanted by the new formula The Katch-McArdle formula, which determines the resting daily energy expenditure (RDEE), is the third equation in existence The Mifflin St. Jeor Equation is utilized in our Basal Metabolic Rate Calculator to provide you with the most precise BMR result. (Amirkalali, 2008)

BMR for woman calculation:

We'll attempt calculating a woman's BMR this time. We will employ the Mifflin and St. Jeor BMR equation for women, which is a slightly modified formula. 10 × weight (kg) + 6.25 × height (cm) – 5 × age (y) – 161 (kcal/day) is BMR (kcal/day).

The final portion is the only distinction between these two formulations, as you may have previously seen. For every guy, we add 5 kcal per day, and for every woman, we subtract 161 kcal per day Let's now concentrate on a 25-year-old model woman who stands at 5 feet, 8 inches tall. She has a 132-pound weight. We can carry out the computations now. (Amirkalali, 2008)

BMR for man calculation – an example:

BMR for man formula, also known as the Mifflin and St. Jeor BMR equation for a man, must be used: BMR (kcal/day) is equal to 10 × kg of weight + 6.25 × cm of height – 5 × age (y) +5(kcal/day).

Assume for the moment that you wish to determine the BMR of a man who weighs 150 pounds and stands 5 feet 4 inches tall. He is 60 years old.

Example2.1:

Men: BMR=(10×weight in kg)+(6.25×height in cm)-(5×age in years)+5

Women: BMR=(10×weight in kg)+(6.25×height in cm)-(5×age in years)-6

The original Harris–Benedict equations were published in 1918 and 1919.

Sex	Units	Calculations of BMR, resulting in kcal/day
Men	Metric	BMR = (13.7516 × weight in kg) + (5.0033 × height in cm) – (6.755 × age in years) + 66.473
	Imperial	BMR = (6.23762 × weight in pounds) + (12.7084 × height in inches) – (6.755 × age in years) + 66.473
Women	Metric	BMR = (9.5634 × weight in kg) + (1.8496 × height in cm) – (4.6756 × age in years) + 655.0955
	Imperial	BMR = (4.33789 × weight in pounds) + (4.69798 × height in inches) – (4.6756 × age in years) + 655.0955

The Harris–Benedict equations revised by Roza and Shizgal in 1984.

Mifflin St. Jeor Calculator:

Your basal metabolic rate (BMR) is determined using the Mifflin-St. Jeor calculation (or equation), and the findings are based on an assumed average. The number of calories burned daily while at rest, or basal metabolic rate, is what you would burn if you were lying in bed.
To calculate your daily caloric burn and BMR, use this activity along with the Mifflin St. Jeor calculator (also known as total daily energy expenditure). (Amirkalali, 2008)

Mifflin St Jeor Equation:

The BMR formula that is most frequently utilized is the Mifflin-St Jeor equation In comparison to the Harris-Benedict equation, it seems to offer a more accurate approximation of real BMR.

According to studies, this equation has a higher probability of accurately estimating basal metabolic rate to within 10% of indirect calorimetry measurements than other formulas.

Because men and women have varied rates of metabolism depending on their gender, there are two separate equations for each.

BMR for men is calculated as follows: (10 × weight [kg]) + (6.25 × height [cm]) – (5 × age [years]) + 5

BMR for women is calculated as follows: (10 × weight [kg]) + (6.25 × height [cm]) – (5 × age [years]) -161

For illustration, let's use the Mifflin St. Jeor equation to get the BMR of a 36-year-old woman who weighs 120 pounds and is 65 inches tall.

To begin, first convert her weight and height to imperial measurements. Here, our weight and length conversion tools may be of assistance.

120 lbs ÷ 2.2 = 54.55 kg 65 inches × 2.54 = 165.1 cm

Then, apply the Mifflin St. Jeor equation to calculate BMR.

BMR = (10 × 54.55) + (6.25 × 165.1) – (5 × 35) – 161 BMR = 1,241 kcal

So, this person has a BMR of 1,41 calories. (Amirkalali, 2008)

Mifflin St. Jeor Formulas :

1-Men - 10 x weight (kg) + 6.25 x height (cm) – 5 x age (y) + 5

2- Women - 10 x weight (kg) + 6.25 x height (cm) – 5 x age (y) – 161 (Amirkalali, 2008)

What is the Mifflin-St Jeor equation : A popular method for calculating the resting metabolic rate [RMR], or the total number of calories burnt while the body is at rest, is the Mifflin-St. Jeor equation.

1-Females: (10*weight [kg]) + (6.25*height [cm]) – (5*age [years]) – 161

2- Males: (10*weight [kg]) + (6.25*height [cm]) – (5*age [years]) + 5 Multiply by scale factor for activity level: Sedentary *1.2 Lightly active *1.375 Moderately active *1.55 Active *1.725 Very active *1.9 (Amirkalali, 2008)

Mifflin St Jeor equation for calculation resting metabolic rate in men?

To calculate your BMR/RMR using the Mifflin-St. Jeor equation , you'll need to use one of two equations: Males: 10 × weight (in kilograms) + 6.25 × height (in centimeters) – 5 × age (in years) + 5. (Amirkalali, 2008)

Mifflin-St Jeor equation for calorie deficit:

The formula for the Mifflin-St Jeor equation is as follows:

1- For men: BMR = (10 x weight in kg) + (6.25 x height in cm) - (5 x age in years) + 5.

2- For women: BMR = (10 x weight in kg) + (6.25 x height in cm) - (5 x age in years) -161 (Amirkalali, 2008)

Chapter Three

On some statistical modeling on food science

The totality of a food's attributes that impact consumer pleasure and adherence to regulatory requirements can be used to define food quality. Therefore, a wide range of factors, including organoleptic properties (such as texture, taste, flavor, smell, and color), nutritional value (such as calorie content and fatty acid composition), shelf life (such as microbial count), and safety conditions (such as the presence of toxins, hormones, and pathogens) are combined to determine food quality.

3.1 Mathematical Modeling of Gastric Emptying And Nutrient Absorption in the Human Digestive System (Moxon, 2017)

According to Berghofer et al. (2008), obesity is defined as having a body mass index of 30 kg/m2. This condition is becoming increasingly prevalent worldwide, with 33.8% of adult Americans and approximately 25% of adult Britons being classified as obese in 2008 and 2012, respectively (McPherson et al., 2007).The rising prevalence of obesity is having a negative impact on society at large and on health care costs. According to McPherson et al. (2007), the cost to society in the UK in 2012 was estimated to be £5.1 billion. If the obesity epidemic continues, it is predicted to cost the country's society £50 billion by 2050. Dietary and physical activity changes throughout time may have contributed to the trend in the prevalence of obesity. About 10,000 years ago, during the Neolithic Revolution, hunter-gatherer communities gave way to diets with higher glycemic loads, which are measured as the area under the blood glucose curve after a meal as a percentage of a reference food that is equi-carbohydrate. various nutrient profiles (e.g., consuming more wheat and grains, etc.), and white bread, multiplied by the quantity of carbs in a meal (Equations 1.1 & 1.2). In 2010, Kendall et al. The industrial revolution drastically altered the human diet around 200 years ago, leading to a rise in processed food consumption and a decline in the amount of fiber in food. The current incidence of chronic food-related diseases is thought to be caused by humans' poor adaptation to modern diets, which is thought to be due to their abrupt shift in diet. Humans are thought to still be acclimated to more ancient surroundings.

Glycaemic Index (GI) is calculated as follows

AUC = Area under the blood glucose curve after a meal

GL is equal to GI times Mmeal.

Meal = mass of ingested carbohydrates

Numerous writers have examined the relationship between human food and obesity, and these studies have been compiled by others to create assessments of the state of the field (Berghofer et al., 2008; Haslam and James, 2005; Kopelman, 2007; Popkin, 2006; Mishra and Dubey, ¨ 2016). These pieces emphasize the higher risk of heart disease, diabetes, hypertension, strokes, and cancer that obese people face, all of which can shorten their life expectancy. Research on the impact of food hydrocolloids and how they might improve health outcomes by reducing or eliminating some common issues is a significant field of study (Gidley, 2013; Kendall et al., 2010; Li and Nie, 2015; Salmeron et al., 1997a; Viebke et al., 2014; Weickert and Pfeiffer, 2008). Numerous theories have been put forth to explain hydrocolloids' negative impact on health. Hydrocolloids have been demonstrated in vitro to decrease glucose absorption through permeable membranes (Gouseti et al., 2014; Tharakan et al., 2010) that was blamed on a decline in the diffusion rate or mixing efficacy (Tharakanet al., 2010). According to certain theories, hydrocolloids may also reduce the absorption of nutrients by inhibiting certain enzymes or encasing absorbable molecules or enzymes (Sasaki and Kohyama, 2012; Slaughter et al., 2002).

3.2 Observations on the use of statistical methods in Food Science and Technology (Nunes, 2015)

Concepts of statistics applied in Food Science

Since the researcher needs to glean as much information as possible from the experimental results, using the appropriate statistical tools is crucial. When work is published in a journal, enough information must be given so that the reader completely comprehends the objectives and findings of the study and, if necessary, permits the work to be repeated. On the other hand, we note that many published studies don't go into enough information about the statistical tests that were performed in order to analyze and understand the published data. Descriptive statistics, which include mean, median, minimum, maximum, standard deviation, and/or coefficient of variation, are frequently the only ones used in results reports. Together with other statistical tests like regression and correlation, When comparing mean results, are frequently predicated on the slavish use of "statistical packages," which may or may not be suitable for the goal. Before applying inferential statistical tests, the researcher must ensure that they understand their foundation. In fact, in order to properly arrange experimental work, comprehend the outcomes within a thorough data structure, and make conclusions based on the work, the researcher must be aware of the options available for pertinent data analysis. It is crucial to assess the statistical quality of the data before moving forward with further analysis, regardless of the kind of experimental design a researcher chooses to employ. Experimental data analysis frequently yields false conclusions if the data quality is subpar. Poor quality data can result from a number of factors, such as insufficient sample testing, non-random sample selection from the test population(s), high measurement uncertainty in the analytical method(s) employed, insufficient training of the analyst, and "censored" values in the analytical results. Prior to establishing an experimental plan, each of these factors should be taken into account, and the researcher is typically in control of them all. An analytical method's bounds may not always be met by experimental data; for example, an analyte's level in a sample may be below the lowest limit or, less frequently, above a method's maximum detection or quantification limit. These outcomes are called, respectively, left- or right-censored values. How ought one to respond to such outcomes? Numerous disciplines, including toxicology, microbiology, and food chemistry, are debating this topic, and there are still some issues to be resolved regarding the acceptability of the process employed to manage censored data.

3.3 Procedures for Estimating Nutrient Values for Food Composition Databases (Schakle, 1997)

There are numerous applications for the food composition information that nutrient databases offer (Rand et al., 1991). Nutrient intake studies of individuals or groups are used by epidemiologists and health researchers to establish links between food ingredients and illness prevention or causation. Based on an examination of their typical eating patterns, dietitians advise patients on dietary modifications. For food labeling, food manufacturers ascertain the nutritional value of their goods. Recipe writers in cookbooks figure out how many nutrients are in each serving. Based on the nutritious content of their products, food service managers create menus for hospitals, schools, and other establishments. The completeness of each food's nutritional profile in the database is necessary for all of these applications of nutrient databases. (that is, contain no missing data) to prevent underestimating the amount of nutrients in a dish, diet, or food label.

1.Using Nutrient Values from a Different, but Similar, Food

It is possible to use the nutritional values from a different food in the same genus or family. The USDA Nutrient Database for Standard Reference has the following instances of nutrient levels imputed in this way, according to Gebhardt (1992): On a solids basis, the vitamin B-6 and folate content of black walnuts (Juglans nigra) is estimated from English walnuts (Juglans regia). The minerals for pears (Pyrus communis) were derived directly from the sources of magnesium, potassium, zinc, copper, vitamin B-6, and folate in Asian pears (Pyrus pyrifolia) Since veal and beef hearts are of the same species but differ in maturity, the folate and vitamin B-6 values for beef hearts were applied to the veal heart based on protein content. Since the amount of carotenoid in a vegetable is frequently correlated with its green or orange color, color is another essential factor to take into account when estimating the carotenoid or vitamin A content of a vegetable. A dark green vegetable like broccoli would not have the same quantity of vitamin A as a white veggie like cauliflower. even if they belong to the same genus. Growing conditions, geographic location, plant maturity, processing or preparation, fortification or other additives, or the cut of meat are other variables that may affect the nutritional heterogeneity across foods in the same family or genus (Rand et al., 1991). For several food classes, generic nutritional profiles have been created by the USDA nutrient database compilers. These combinations make it easier to estimate the nutritional values of items in the group that haven't yet had their chemical makeup checked for certain potentially useful nutrients. For instance, specific vitamin and mineral values for other tropical and subtropical fruits were used to determine the necessary amounts for the tropical fruits acerola, carambola, passionfruit, and sapodilla (Gebhardt, 1992).

2.Calculating Nutrient Values:

Nutrient values computed from raw data for a cooked or processed product. A food's nutritional worth is often recognized for it when it is raw, but it hasn't been chemically examined for the same meal after it has been cooked. Both the cooked yield and the nutrient retention must be taken into account in order to assess the nutritional content of the prepared food (McCarthy, 1992). The USDA has calculated nutrient retention factors for vitamins and minerals for categories of foods and different cooking techniques using information from paired samples of raw and cooked foods and the subsequent formula (Murphy et al., 1975):

$$\% \text{ true nutrient retention} = \frac{\text{nutrient content per g cooked food} * \text{g cooked food}}{\text{nutrient content per g raw food} * \text{g raw food}} * 100.$$

For use with their survey database, the USDA has produced a table of nutrient retention factors for nine vitamins and nine minerals in 260 food groups (USDA, 1993). Versions of the USDA Agriculture Handbook 8 Series, Composition of Foods (USDA, 1976–1993) that cover game, fish, poultry, vegetables, legumes, and beef, pork, lamb, and calves provide additional nutrient retention tables. Nutrient losses from drainage and heating are two of the retention reasons. A yield component needs to be included if there is moisture gain or evaporative loss (Rand et al., 1991). USDA publications Agriculture Handbook 102: Food Yields Summarized by Different Stages of Preparation (USDA, 1975) and the Agriculture Handbook 8 Series are two sources of yield data. Composition of Foods (USDA, 1976–1993), in addition to global databases like The Composition of Foods (Holland et al., 1991) by McCance and Widdowson. The application of cooked yields and nutrient retention factors in nutrient value estimation is demonstrated in the following example: 0.344 mg of vitamin B6 per 100 g of raw halibut; 90% of the vitamin's nutrients are retained when broiled; 73% of the vitamin is yielded when broiled; 0.344 mg of vitamin B-6 * 90% retention = 0.310 mg of vitamin B6; 0.310 mg of vitamin B-6 per 73 g cooked yield = 0.424 mg of vitamin B6 per 100 g of broiled halibut. It is anticipated that 100% of some nutrients will be retained during cooking. In these circumstances, The yield factor alone can be used to calculate the amount of nutrients in 100 g of cooked food: Assume that no protein is lost throughout the cooking process; 20.81 g of protein per 100 g of raw halibut; a 73% yield of broiled halibut leaves 20.81 g of protein in 73 g of broiled halibut, or 28.51 g of protein per 100 g of broiled halibut. It is also possible to estimate the nutritious value of a cooked food from that of a raw food by using the percentage solids of both: 88.25% of uncooked kidney beans are made up of solids and 11.75% water; Cooked kidney beans have 33.06% solids and 66.94% water; raw kidney beans have 394.1 mcg folacin per 100 g; the amount of folacin retained in the beans after they are boiled for 45–75 minutes is 45%; the amount of folacin in the raw beans is 394.1 mcg per 88.25 g solids. For every 100 grams of cooked beans, 1 33.06 g of solids in CKD beans is 147.6 mcg of folacin; multiplying this amount by 45% retention to get 66.4 mcg of folacin per 100 grams of cooked beans. (b) Nutrient values computed using data on segments that can be separated. Based on physical composition data, the nutritional values of beef or poultry cuts can be computed using the proportions of the separable flesh, fat, and/or skin. The yield information for the percentage of flesh, fat, and/or skin for chicken, hog, beef, lamb, and veal in different meat cuts or chicken parts may be found in the USDA Agriculture Handbook 8 Series (USDA, 1976–1993). Posati (1985) provides an example of a typical nutritional computation using information on the physical makeup of raw chicken thighs with skin:

Tissue	Percentage of Cut(edible portion)(g/100g)	Cholesterol (mg/100g)
Thigh meat	73.0	83
Skin	16.1	109
Separable	10.9	58

mg cholesterol per 100 g raw chicken thigh with skin

= (83 * 0.730) + (109 * 0.161) + (58 * 0.109) = 84 mg

Calculating nutrient values from other components in the same food. Specific calculations may be used to derive a nutrient value from one or more nutrients with a known value, for example:

(a) Energy. The Atwater method of energy calculation uses factors to calculate energy from protein, fat, carbohydrate, and alcohol (Merrill et al., 1973).

(1) The energy calculation using general Atwater factors is the following:

energy (kcal) = (4 kcal/g protein * g protein) + (9 kcal/g fat * g fat)

+ (4 kcal/g carbohydrate * g carbohydrate) + (7 kcal/g alcohol 1 g alcohol)

(2) The British food tables use 3.75 kcal per g carbohydrate instead of the 4 kcal per g (Holland et al., 1991) in the above calculation.

(3) More specific energy factors based on energy availability for different types of foods are used by the USDA to calculate energy values in their nutrient tables (USDA, 1976–1993). Following are a few examples of pecific Atwater factors:

	Protein(kcal/g)	fat(kcal/g)	carbohydrate(kcal/g)
oats	3.62	8.37	4.12
Oat bran	1.62	8,37	2.35
milk	4.27	8.79	3.87
carrots	2.78	8.37	3.84
beef	4.27	9.02	3.68

(b) Protein. Protein values are commonly calculated from the analyzed nitrogen content of a food. The general conversion factor is 6.25 g protein per gram of nitrogen. Protein values in the USDA nutrient tables are calculated from nitrogen using the factors of Jones which are more specific for different food categories (Jones, 1941).

(c) Carbohydrate. Nutrient databases may provide values for "total carbohydrate" or for "available carbohydrate." Total carbohydrate values in the USDA tables are calculated by difference using the following formula for 100 g of food (Merrill et al., 1973):

carbohydrate = 100 g - (g protein + g fat + g alcohol + g ash + g water).

Carbohydrate calculated in this manner includes dietary fiber, as well as other components of a food that are not protein, fat, alcohol, ash, or water. Some nutrient database compilers calculate total carbohydrate from the sum of sugars, starch, oligosaccharides, and dietary fiber (Klensin et al., 1989).

(d) Vitamin A. Vitamin A can be calculated as the sum of vitamin A activity of retinol and the provitamin A carotenoids which are expressed below as beta-carotene equivalents (FAO/WHO, 1967; National Research Council, 1989).

vitamin A (RE) = mcg retinol + 1/6 (mcg beta-carotene equivalents) or vitamin A (IU) = (mcg retinol 1 3.33) + (mcg beta-carotene equivalents * 1.67)

Body Mass Index (BMI) 3.4

BMI is calculated using the equation: BMI = (weight in kilograms) / (height in meters)^2. It’s used to assess a person’s weight relative to their height.

Body Mass Index (BMI) is a person's weight in kilograms (or pounds) divided by the square of height in meters (or feet). A high BMI can indicate high body fatness. BMI screens for weight categories that may lead to health problems, but it does not diagnose the body fatness or health of an individual. (Zierle_Ghosh, 2018)

How to calculate your BMI?

The BMI calculation divides an adult's weight in kilograms (kg) by their height in metres (m) squared. For example, if you weigh 70kg (around 11 stone) and are 1.73m (around 5 feet 8 inches) tall, you work out your BMI by: squaring your height: 1.73x1.73 = 2.99. dividing 70 by 2.99 = 23.41. (Zierle_Ghosh, 2018)

What is the normal number of BMI?

Adult BMI Calculator and BMI Weight Status

Below 18.5 Underweight

18.5—24.9 Healthy Weight

25.0—29.9 Overweight

30.0 and Above Obesity (Zierle_Ghosh, 2018)

Why is BMI important?

BMI is an estimate of body fat and a good gauge of your risk for diseases that can occur with more body fat. The higher your BMI, the higher your risk for certain diseases such as heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems, and certain cancers. (Zierle_Ghosh, 2018)

What is a good BMI for my age?

1-18.5 to 24.9 If your BMI is: Under 18.5 - you are very underweight and possibly malnourished.

2- 18.5 to 24.9 - you have a healthy weight range for young and

middle-aged adults.

3- 25.0 to 29.9 - you are overweight. (Zierle_Ghosh, 2018)

BMI is calculated using the following formulas:

Units Formula and calculation

Kilograms and meters Formula: weight (kg) / [height (m)]2

With the metric system, the formula for BMI is weight in kilograms divided by height in meters squared. Since height is commonly measured in centimeters, divide height in centimeters by 100 to obtain height in meters.

Example: Weight = 68 kg, Height = 165 cm (1.65 m)

Calculation: 68 ÷ (1.65 x 1.65) = 24.98

Pounds and inches Formula: weight (lb) / [height (in)]2 x 703

Calculate BMI by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703.

Example: Weight = 150 lbs, Height = 5’5” (65″)

Calculation: 150 ÷ (65 x 65) x 703 = 24.96 (Zierle_Ghosh, 2018)

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پوخته

لەم توێژینەوەیەدا هەندێک لە بەکارهێنانە بیرکارییەکان لە زانستی خۆراک و خۆراکدا دەکۆڵینەوە. یەکەم: پێناسە و بنەماکانی خۆراک و چارەسەری خۆراک پێشکەش دەکەین. پاشان ئێمە مۆدێلی خۆراک و پرۆسەی خۆراک دەخوێنینەوە. سەرەڕای ئەوەش، ئێمە زۆرترین بەهای نوێنەرایەتی داتای بەردەوام و چڕی خۆراک دەخوێنینەوە. لەگەڵ ئەوەشدا، ئێمە لێکۆڵینەوە لە مۆدێلی بیرکاری دەکەین بۆ بەتاڵکردنەوەی گەدە و هەڵمژینی خۆراک لە سیستەمی هەرسکردنی مرۆڤدا و تێبینیەکان لەسەر بەکارهێنانی میتۆدە ئامارییەکان لە زانستی خۆراک و تەکنەلۆژیادا، لە هەموو بەکارهێنانەکاندا چەندین نموونە چارەسەر دەکەین کە بەکارهێنانەکان ڕوون دەکاتەوە.