EDUZONE: International Peer Reviewed/Refereed Multidisciplinary Journal (EIPRMJ), ISSN: 2319-5045
Volume 11, Issue 2, July-December, 2022, Available online at: www.eduzonejournal.com

Recent Parameters and Techniques used for Assessing the Nutritional Quality of Foods-A Review

Dr. D. Padmavathi[1], Dr. Praveen B.M[2]

[1]Post Doctoral Research Scholar, Dept of Science & Engineering Srinivas University, Mangalore- 575001, India
[2]Director, Research and Innovation Council, Mukka, Mangaluru-574146 Karnataka , India

INTRODUCTION

Feeding the world's growing population requires great quantities of food and accurately measuring the quality of that food is vital to sustained personal and economic health. Food quality testing is necessary to monitor and control quality parameters throughout the fresh produce supply chain to meet consumer demands and extend shelf life. A good and balanced-diet consists of all the nutrients required for the metabolism, *viz.*, carbohydrates, protein, oils and fats, minerals and vitamins in right proportion as per the needs of different age groups. Cereals such as rice, wheat, maize and barley and millets provide protein and energy, while pulses and oilseeds are the rich sources of protein and energy, respectively. The diets based on cereals and pulses are generally deficient in one or the other nutrient. Protein-calorie malnutrition is wide spread among majority of population in developing countries. In order to effectively control protein-calorie malnutrition, it is essential to know the nutritional requirements as well as nutritive quality of various food grains. The presence of various anti-nutritional factors like proteolytic enzyme inhibitors, polyphenols, phytic acid and lathyrogens in cereals and pulses can result in impaired growth or produce acute and lethal effects and also reduce the availability of otherwise good proteins in the diet. The presence of excessive amounts of fibre and tannins (polyphenols) in cereals might be responsible for their reduced digestibility and lower biological value. Likewise, the quality of oil is also an important area concerning human health. The oilseed like mustard may have abnormal content of erucic acid or glucosinolates. Therefore, nutritional evaluation of food stuffs becomes important for ensuring good and healthy diet.

Keywords: Nutrition, Nutrients, analysis, Food, Diet, Parameters, Techniques, Food Quality

What are Food Quality Testing Parameters?
Any food attributes used to evaluate quality can be deemed quality parameters. However, quality means different things to different people in the food supply chain, so the specific parameters tested can vary.

What is the nutritional value?
The ingredient list simply tells you which ingredients a food contains. The nutritional value digs a little deeper. It then analyzes what these ingredients are made up of and groups these components.

Energy content
First nutritional value states how much energy a product contains. This is the amount of energy that a human body can get out of these ingredients. We all need energy on a daily basis to function properly.

Macronutrients
Secondly, the nutritional value states which types of molecules are present in the food and how many. These molecules are split into functional groups. The most common molecules are:

- Carbohydrates
- Fats
- Proteins

These are macromolecules. Almost every food and drink contains at least one of these (except for pure water for instance). We humans need them to live. These ingredients are also the main energy source of foods.

Carbohydrates and fats can be split up into smaller groups of molecules. For instance, carbohydrates might be split into sugars, and fats can be split into saturated and unsaturated fats.

Micronutrients

There's more to good food than just proteins, carbohydrates and fats. We also need certain vitamins and minerals. These can also be found on labels.

Foods are variable

Before attempting to determine the nutritional value of a product, keep in mind that foods are highly variable. The less processed a product is, the more this is the case.

- An unripe vs. a ripe apple can make a huge difference with regard to the amount of sugar in the apple.
- Cow's milk has a different composition in summer than it does in winter.
- Beef from a fat cow is different from that of a skinny cow.
- Cocoa harvested from one species can be quite different from that of another species.
- The leg of a chicken has quite a different fat content than the breast does.
- Broccoli stems contain different components that the flowers do.

As such, it is almost impossible to give very precise correct nutritional values for food. There will almost always be some variations, simply because you can't analyze every apple from a batch and give it a different value. Often nutritional values are averages for a specific product.

Determining the nutrient content in three ways

There are three main ways in which you can determine these:

1. The analytical route
2. The literature route
3. Using some math

1) Analyze the contents in a lab

There exist a wide range of analytical methods that can be performed on foods to determine their nutritional value. Methods exist to determine the types and amounts of sugar, fats, etc. Laboratories will state which methods are required to get a full nutritional profile of a product.

All of the analyses required are chemical analysis techniques. These techniques tend to only use very small amounts of sample to make a determination. Knowing how variable products can be, it is important to make sure that this small sample size is actually representative of the product you're testing.

Protein analysis – Determining nitrogen content using Kjeldahl

Foods tend to contain a lot of different proteins. It is virtually impossible to analyze how much there is of each protein, nor does it provide a lot of added value. That's why most labels only require the overall protein content.

Proteins are some of the only molecules in food that contain nitrogen. As such, by analyzing how much nitrogen a product contains, you can calculate the overall protein content. There are two main analysis techniques used for this: the Kjeldahl method and the Dumas method.

Depending on where you live, you might also need to take into account the quality of the protein. Some proteins are more 'complete' than others. Some countries require you to correct the overall protein content with a separately determined factor (e.g. a PDCAAS score).

Carbohydrate analysis
There exist a lot of different carbohydrates, from small to large. Unlike proteins, they don't contain a unique atom. On the contrary, it is quite similar to fats. It's why in a lot of cases, the carbohydrate content is etermined by taking the total mass of a product and subtracting all the other components (fats, protein, water, ash, etc.). What remains is assumed to be the carbohydrates.

If you do need to know exactly which types of sugars a product consists, it is possible to determine those using a technique called liquid chromatography.

Fat content analysis
Most of the fats in foods are the so-called triglycerides. An important property of fats is that they don't dissolve in water. As such, they can be extracted from most products. This extraction method can be used to determine the overall content.
If you need to know exactly which tryglycerides are present in a food you will have to use a more advanced technique such as gas chromatography. This is however quite an expensive and complex technique.

2) Used published values from literature
Over time, a wide range of products have been analyzed for their nutritional content. When determining the nutritional value of your product, you might be able to use these existing values for your product.

A lot of countries have their own databases of generally acknowledged nutritional values for food products. The USDA, in the USA, has a very extensive, publicly accessible database. The Netherlands has one as well, as do many other countries.
Let's start with the 2nd option: the literature route. In this case, no analysis of the actual final product is done. Instead, databases which contain a lot of data on nutritional values of all sorts of products are used.

When baking these crackers you evaporate a lot of moisture. This can make it challenging to determine the nutritional value just using calculations. Instead, you might need to use analytical methods.

3) Calculate your nutritional value
If your product is made with your own recipe and has a unique composition, you will not be able to find literature values for it. However, you may find the nutritional value of the ingredients that you used. If so, you can use those to calculate the nutritional value of your product.

1. You product is made of 25% ingredient A and 75% ingredient B.
a. Ingredient A contains 10% fat and 50% carbohydrates
b. Ingredient B contains 7% protein
2. The overall composition will be:
a. Fat: 10 / 100 * 25 + 0 =2,5%
b. Carbohydrates: 50 / 100 * 25 = 12,5%
c. Protein: 7 / 100 * 75 = 5,25%

These calculations can be quite simple and reliable if all you're doing is mixing ingredients. However, if a lot of chemical reactions take place in your product, or if significant amounts of water evaporate, this no longer works well. Some molecules might have reacted and become something different for instance.

Determining energy content is a simple calculation
Once you know the composition of your product, you can easily determine the energy content of your food. The energy content of a food is determined by the amount components that your body can use to make energy. These are the three macronutrients, protein, carbohydrates, and fat, but also alcohol, polyols (strictly a type of carbohydrate) and fibers (also a carbohydrate type).

The energy content of a food is given in kcal (often referred to as Calories) and/or kJ (kilojoule). Converting from kcal to kJ is a simple set calculation1 kcal = 4,18 kJ

Set conversion values
Research has shown how much energy our body can make from these macronutrients. We know that:

- 1 gram of fats provides 9 kcal of energy
- 1 gram of carbohydrates = 4 kcal
- 1 gram of fibers = 2 kcal
- 1 gram of polyols = 2,4 kcal
- 1 gram protein = 4 kcal
- 1 gram of alcohol = 7 kcal

Nutrition testing is a requisite part of analytical chemistry. It determines the food's nutrient contents, including structure, chemical composition, quality control, processing, and contamination. Trade and food laws impose nutrition testing. **Food Nutrition testing** is not only for human food but also for pet feeds and dietary supplements

Reasons for food product analysis

- Manufacturer declaration about the product is verified using nutrition testing mainly about the ingredients used
- The test is through from raw materials, start and end of the manufacturing process and the final product
- Food testing is through to ensure food manufacturers meet the standards and laws
- To make a nutrition label which is must for every food product
- Any nasty rumour about a product's nutrition can be empty using nutrition analysis

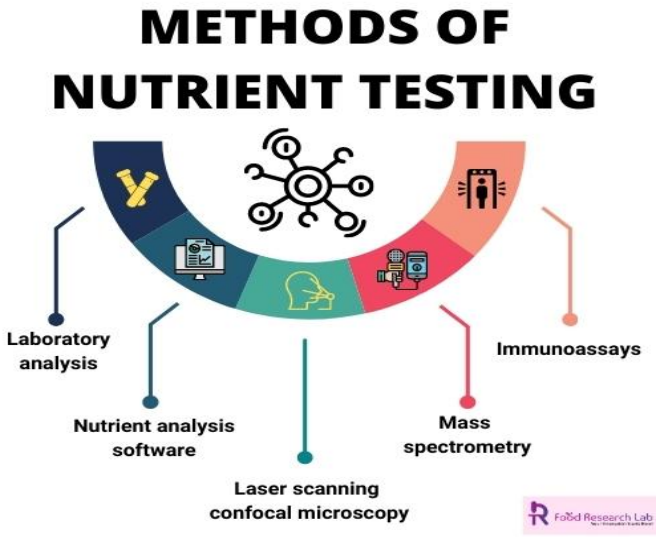
Nutrition label
Nutrition label consists of details that a particular quantity of a specific food product consists of how much quantity and **nutrition label testing** and other essential compounds and the safety proof of those compounds.

The variation in nutrition labels majorly

- Dual column label
- Single-ingredient sugar labels

Methods for nutrient analysis
There are various methods which are certified by the officials (FDA) for nutrient analysis

- Laboratory analysis
- Nutrient analysis software
- Laser scanning confocal microscopy
- Immunoassays
- Mass spectrometry



Laboratory analysis
There are specific testing facilities available; the prepared food materials are given to these facilities to estimate the nutrition quantity and quality in the **food nutritional analysis lab**. Suppose the food is to be ready in a certain way before consuming it is necessary to estimate the after the nutritional value of food. It depends on the method of the process that is most common for ingredients to be cast-off in cooking. The laboratory studies need specific guidance and knowledge

Nutritional analysis testing software
Nutrition analysis software in **food testing companies** combines food portion size information, population dietary reference values and nutrient calculations. It is the most time consuming than the manual process, but it certainly depends on standard recipes of the particular product

Some of the **nutrition analysis** software is

- Nutrium
- My pt hub
- Nutrasoft
- Indigo
- Nutracoster
- Genesis r&d food labelling
- Chieftec
- Nutritionist pro
- A la calc
- Hawk scanner
- Minimax
- Calculate
- Dieterich
- Food meal planner

Food works nutrition labelling

Laser scanning confocal microscopy (LSCM)
LSCM illuminates the sample using highly intensified laser beams rather than visible light, analyzing samples at various focal planes, even using a small piece. Using the microscope details about different consecutive optical sections of the specimen can be obtained using the microscope details' adjustment. The significant applications of LSCM in food analysis are

- Description of fats in bulk
- Biopolymer mixtures
- Emulsion system
- Gel-like emulsion

The significant advantage of lscm is the 3d analysis of the product. It uses compound-specific fluorescent probes which make it possible to image the presence, state and spatial organization of the compounds

Immunoassay
Immunoassay techniques are more specific and sensitive, utilizing immunological reaction (antigen and antibody response) to detect naturally occurring constituents, pesticide residue, microbes or their by-products related to food analysis. The various immunoassay techniques include ELISA (enzyme-linked immunosorbent assay), ria (radioimmunoassay) etc. Utilizes both monoclonal and polyclonal antibodies

Advantages

- Cost-efficient
- Simple equipment
- Less analysis time

Disadvantages

- Maintaining reliability
- Unstable sensitivity

Mass spectrometry

Mass spectrometry uses mass to charge ratio to analyze the samples, giving a detailed account of their structures. Gas chromatography (GC-ms) is majorly used in food analysis. Sterols, alcohol, fatty acid, and low mass carbohydrates are analyzed numerically, including pesticides, pollutants, toxins, and drugs. It is used for the quantification of polyphenols in fruits and vegetables

Advantages

- It provides a sensitive response to the most analyte
- It includes information about a specific class of compound
- It includes information about the various structure of the compound
- It has high resolution and separation capacity
- Less time consuming comparatively than other methods
- It determines molecular weight and fragmentation pattern of the compounds
- Simple rapid and reproducible technique
- Good accuracy and precision

Disadvantages

- Low sensitivity
- Affected by fluctuation in temperature and flow rate

Specific nutrient analysis in food nutrition testing services

- Anti nutrient testing
- Amino acid testing
- Carbohydrate testing
- Enzyme testing
- Fatty acid testing
- Fats and oil testing
- Food allergen testing
- Trace metal analysis
- Preservative and antioxidant testing
- Proximate
- **Shelf-life testing**
- Vitamin testing

Importance for nutrition analysis

In the modern world, new functions than the standard supply of energy and nutrients are assigned to nutrition such as food components with biological activities. It is essential to know about distribution and amount of bioactive compounds in the food.

Nutritional Analysis Overview:

AQSIQ laboratory offers full Nutritional Labeling services. The two most common methods for determining the nutritional content of a product are Laboratory Based Analysis and Database Analysis.

Laboratory Based Analysis:

This method simply requires the client to send in the product(s) to be tested (minimum of 500g of sample needed). The laboratory utilizes scientific methods and equipment to physically analyze your sample for the various components that make up the nutritional information needed. Virtually any food sample can be analyzed with the laboratory based method.

Database Analysis:

This method requires that the client sends in detailed information about each product such as recipe, nutritional facts per 100g of each ingredient, and pre and post processing weights. Not all food types are appropriate for the Database method. The Database method is conducted strictly via paperwork (email, fax, phone etc), no physical sample is required for analysis.

Camera Ready Nutrition Facts Panel:
When the appropriate analysis is selected and performed AQSIQ laboratory can provide a camera ready nutrition facts panel, ready for labeling, based on the data derived from analysis. Several formats are available.

Laboratory Based Nutritional Analysis
AQSIQ laboratory offers Laboratory based Nutritional analysis compliant with AQSIQ Labeling Laws. Laboratory based nutritional analysis methods require a physical sample of the product(s) be sent to the laboratory. The samples are then prepped and analyzed in the laboratory using various scientific instruments and techniques to yield data that is specific and unique to the product.

Laboratory based nutritional analysis can be used for virtually any food type. This method can be used when:

1. General Nutritional Labeling needs
2. Validating manufacturer / supplier nutritional information
3. Validating data generated from software based database analysis
4. Product contains unique or exotic ingredients or processing techniques
5. Analyzing food for animals (pet foods and agricultural feeds)
6. Accurate nutrient per 100g values are needed for CofA's or Database inclusion

Reports will feature values per 100g and per serving size (when provided) of the product. Where applicable, % RDI and % DV values will also be provided. Additional voluntary nutrients, vitamins and minerals are available – please inquire us.

Laboratory Based Nutritional Analysis for Mandatory Nutrients Include

1. Protein
2. Moisture
3. Ash
4. Fat Profile (total, sat, mono, poly and trans fat)
5. Sugar profile
6. Total Dietary Fiber
7. Sodium
8. Calcium
9. Iron
10. Cholesterol
11. Vitamin A
12. Vitamin C
13. Carbohydrates
14. Calories
15. Calories from Fat

CONCLUSION

Food analysis mainly focuses on the nutritional value of the products, and additional compounds added, the presence of any toxic elements, the effect of food processing and quality. The nutritional analysis is a complex testing but the fundamental variable for food labelling, which is mandatory throughout society's benefits

REFERENCES

[1] Mackison, D., Wrieden, W. L., & Anderson, A. S. (2010). Validity and reliability testing of a short questionnaire developed to assess consumers' use, understanding and perception of food labels. *European journal of clinical nutrition*, *64*(2), 210-217.

[2] Silk, K. J., Sherry, J., Winn, B., Keesecker, N., Horodynski, M. A., & Sayir, A. (2008). Increasing nutrition literacy: testing the effectiveness of print, web site, and game modalities. *Journal of nutrition education and behaviour*, *40*(1), 3-10

[3] . Pustjens A., Muilwijk M., Weesepoel Y., van Ruth S. *Advances in Food Authenticity Testing*. Elsevier; London, UK: 2016. Advances in authenticity testing of geographical origin of food products; pp. 339–367. [Google Scholar]

[4] . Zheng Y., Ruan G., Li B., Xiong C., Chen S., Luo M., Li Y., Du F. Multicomposition analysis and pattern recognition of Chinese geographical indication product: vinegar. *Eur. Food Res. Technol.* 2014;238:337–344. doi: 10.1007/s00217-013-2135-2. [CrossRef] [Google Scholar]

[5] De Higuera J.M., da Silva A.B.S., de Oliveira A.F., de Araujo Nogueira A.R. Multi-elemental determination in meat samples using multi-isotope calibration strategy by ICP-MS. *Food Chem.* 2020;303:125395. doi: 10.1016/j.foodchem.2019.125395. [PubMed] [CrossRef] [Google Scholar]

[6] Vasić V., Đurđić S., Tosti T., Radoičić A., Lušić D., Milojković-Opsenica D., Tešić Ž., Trifković J. Two aspects of honeydew honey authenticity: Application of advance analytical methods and chemometrics. *Food Chem.* 2020;305:125457. doi: 10.1016/j.foodchem.2019.125457. [PubMed] [CrossRef] [Google Scholar]

[7] 53. Dell'Aquila C., Neal A.L., Shewry P.R. Development of a reproducible method of analysis of iron, zinc and phosphorus in vegetables digests by SEC-ICP-MS. *Food Chem.* 2020;308:125652. doi: 10.1016/j.foodchem.2019.125652. [PubMed] [CrossRef] [Google Scholar]

[8] Astolfi M.L., Marconi E., Protano C., Canepari S. Comparative elemental analysis of dairy milk and plant-based milk alternatives. *Food Control.* 2020:107327. doi: 10.1016/j.foodcont.2020.107327. [CrossRef] [Google Scholar]

[9] Chen L., Li X., Li Z., Deng L. Analysis of 17 elements in cow, goat, buffalo, yak, and camel milk by inductively coupled plasma mass spectrometry (ICP-MS) *RSC Adv.* 2020;10:6736–6742. doi: 10.1039/D0RA00390E. [CrossRef] [Google Scholar]

[10] Voica C., Iordache A.M., Ionete R.E. Multielemental Characterisation of Honey Using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) Fused with Chemometrics. *J. Mass Spectrom.* 2020;55:e4512. doi: 10.1002/jms.4512. [PubMed] [CrossRef] [Google Scholar]

[11] Spanu A., Langasco I., Valente M., Deroma M.A., Spano N., Barracu F., Pilo M.I., Sanna G. Tuning of the amount of se in rice (oryza sativa) grain by varying the nature of the irrigation method: Development of an ICP-MS analytical protocol, validation and application to 26 different rice genotypes. *Molecules.* 2020;25:1861. doi: 10.3390/molecules25081861. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[12] Potortì A.G., Bua G.D., Turco V.L., Tekaya A.B., Beltifa A., Mansour H.B., Dugo G., Di Bella G. Major, minor and trace element concentrations in spices and aromatic herbs from Sicily (Italy) and Mahdia (Tunisia) by ICP-MS and multivariate analysis. *Food Chem.* 2020;313:126094. doi: 10.1016/j.foodchem.2019.126094. [PubMed] [CrossRef] [Google Scholar]

[13] Wang F., Zhao H., Yu C., Tang J., Wu W., Yang Q. Determination of the geographical origin of maize (Zea mays L.) using mineral element fingerprints. *J. Sci. Food Agric.* 2020;100:1294–1300. doi: 10.1002/jsfa.10144. [PubMed] [CrossRef] [Google Scholar]

[14] Syahfitri W.Y.N., Kurniawati S., Adventini N., Damastuti E., Lestiani D.D. Macro elemental analysis of food samples by nuclear analytical technique. *J. Phys. Conf. Ser. IOP Publ.* 2017;860:012023. doi: 10.1088/1742-6596/860/1/012023. [CrossRef] [Google Scholar]

[15] Beaty R.D., Kerber J.D. *Concepts, Instrumentation and Techniques in Atomic Absorption Spectroscopy.* 2nd ed. The Perkin-Elmer Corporation; Norwalk CT, USA: 1993. [Google Scholar]

[16] Elmer P. PinAAcle 900 Series Atomic Absorption Spectrometers. [(accessed on 8 June 2020)]; Available online: https://www.perkinelmer.com/lab-solutions/resources/docs/bro_pinaacle900family.pdf

[17] Mohebbi M., Heydari R., Ramezani M. Determination of Cu, Cd, Ni, Pb and Zn in edible oils using reversed-phase ultrasonic assisted liquid–liquid microextraction and flame atomic absorption spectrometry. *J. Anal. Chem.* 2018;73:30–35. doi: 10.1134/S1061934818010069. [CrossRef] [Google Scholar]

[18] Zeiner M., Cindrić I.J., Kandler W., Stingeder G. Trace determination of skin-irritating metals in tea tree oil by GFAAS. *Microchem. J.* 2018;136:101–105. doi: 10.1016/j.microc.2016.12.016. [CrossRef] [Google Scholar]