



Proximate Analysis and Nutritional Evaluation of Selected Food Samples: Cereals, Legumes, Fruits, Vegetables, and Spices

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ABSTRACT

Proximate analysis is a fundamental and widely accepted approach for assessing the nutritional quality and chemical composition of food materials. The present investigation systematically evaluated selected cereals, millets, legumes, fruits, vegetables, and spices commonly consumed in India for their proximate composition using standard Association of Official Analytical Chemists (AOAC) methods. The parameters analyzed included moisture content, total ash, crude protein, crude fat, crude fiber, and total carbohydrate content. Results revealed considerable variation among food groups: cereals and millets were rich in carbohydrates (68–73%) and moderate in protein (10–11%); legumes (kidney beans, peas) showed higher protein concentrations, especially kidney beans (22.4%); fruits and vegetables exhibited high moisture content (77–92%) with notable dietary fiber; and spices demonstrated low moisture with concentrated ash, fat, and fiber values. Nutmeg recorded the highest fat content (36.42%), while black pepper exhibited the greatest fiber content (11.08%) among all spices. The data generated provide valuable baseline information for nutritional evaluation, food quality assessment, dietary planning, and further food preservation studies.

Keywords: Proximate Analysis, Nutritional Evaluation, Cereals, Legumes, Fruits, Vegetables, Spices, AOAC Methods, Food Composition, Dietary Fiber.

INTRODUCTION

Food plays a critical role in maintaining human health by supplying essential nutrients required for growth, development, metabolism, and disease prevention. The nutritional value of food is largely determined by its chemical composition, which also influences shelf life, storage stability, and susceptibility to microbial spoilage (FAO, 2020). With increasing awareness about nutrition and food safety, the evaluation of food composition has become an indispensable aspect of food science and technology (AOAC International, 2019). Proximate analysis is a classical, systematic, and widely accepted method for determining the major constituents of food—namely moisture, ash, crude protein, crude fat, crude fiber, and carbohydrates. These parameters provide a general idea of the nutritional quality and energy value of food products (James, 1995). Moisture content affects texture, palatability, and microbial

stability, whereas ash content indicates total mineral composition (Kirk & Sawyer, 1991). Proteins are essential for body building and repair, fats serve as concentrated energy sources and carriers of fat-soluble vitamins, and carbohydrates act as the primary energy source for humans (Pomeranz & Meloan, 1994). Dietary fiber improves digestive health and reduces risk of chronic diseases such as diabetes and cardiovascular disorders (Slavin, 2013).

Cereals and millets constitute staple foods for large populations in developing countries and contribute significantly to daily energy and protein intake (Gupta et al., 2012). Legumes such as kidney beans and peas are valued as cost-effective, high-protein dietary components, especially in vegetarian diets (Boye et al., 2010). Fruits and vegetables are rich sources of vitamins, minerals, antioxidants, and dietary fiber, and their regular consumption is associated with improved health outcomes (WHO, 2021). Spices, though consumed in small quantities, possess high nutritional and medicinal value due to their concentrated minerals, essential oils, and bioactive compounds (Peter, 2012).

Despite their importance, comprehensive nutritional data on locally available food items remain limited in many regions. The present study was therefore undertaken to evaluate the proximate composition of selected cereals, millets, legumes, fruits, vegetables, and spices using standard AOAC analytical methods. The findings will contribute to nutritional databases, support food quality assessment, and aid in dietary planning.

Objectives of the Study

The primary objectives of this research were: (a) to determine the proximate composition of selected food samples from different food groups; (b) to analyze moisture, ash, protein, fat, fiber, and carbohydrate content of each sample; (c) to compare nutritional profiles across different food categories; and (d) to provide reliable nutritional data for dietary and food processing applications.

MATERIAL AND METHOD

Sample Collection and Preparation

The food samples analyzed were carefully selected to represent five major dietary categories. All samples were procured from local markets and transported to

the laboratory in clean polyethylene bags. Table 1 presents the complete list of samples along with their scientific names and assigned codes.

Table 1. List of Food Samples Analyzed with Scientific Nomenclature

Category	Sample Name	Code	Scientific Name
Cereals	Sorghum	S1	<i>Sorghum bicolor</i>
Cereals	Pearl Millet	PM1	<i>Pennisetum glaucum</i>
Legumes	Kidney Beans	L1	<i>Phaseolus vulgaris</i>
Legumes	Peas	L2	<i>Pisum sativum</i>
Fruits	Fig	F1	<i>Ficus carica</i>
Fruits	Sweet Lemon	F2	<i>Citrus limetta</i>
Fruits	Guava	F3	<i>Psidium guajava</i>
Vegetables	Fenugreek	V1	<i>Trigonella foenum-graecum</i>
Vegetables	Potato	V2	<i>Solanum tuberosum</i>
Vegetables	Cabbage	V3	<i>Brassica oleracea</i> var. <i>capitata</i>
Spices	Cinnamon	SP1	<i>Cinnamomum verum</i>
Spices	Nutmeg	SP2	<i>Myristica fragrans</i>
Spices	Clove	SP3	<i>Syzygium aromaticum</i>
Spices	Black Pepper	SP4	<i>Piper nigrum</i>

Sample preparation followed standard protocols: (a) Fresh, disease-free samples were selected and washed thoroughly with distilled water to remove dust, pesticides, and surface microbes; (b) Samples were peeled where necessary and cut into small uniform pieces; (c) Dried samples were ground into fine powder using a laboratory grinder; (d) Powdered samples were stored in airtight containers until further analysis (Ranganna, 1986).

Moisture Content Determination

Moisture content was determined using the oven-drying method (AOAC 925.10). Approximately 5 g of each sample was weighed into a pre-dried crucible and dried in a hot air oven at 105 °C until constant weight was achieved. The moisture content was calculated as the percentage loss in weight:

$$\text{Moisture (\%)} = [(W_1 - W_2) / W_1] \times 100$$

where W_1 = initial weight and W_2 = final weight after drying.

Total Ash Content Determination

Total ash content was estimated by incinerating dried samples in a muffle furnace at 550–600 °C for 4–6 hours (AOAC 923.03). The inorganic residue obtained represented the total mineral content of the sample. Ash (%) = (Weight of Ash / Sample Weight) × 100.

Crude Protein Determination

Crude protein content was determined by the Kjeldahl method (AOAC 984.13). Samples (1 g) were digested with concentrated H₂SO₄ in the presence of a catalyst. The liberated ammonia was distilled into boric acid and titrated with standard HCl. The nitrogen content was multiplied by a conversion factor of 6.25 to obtain crude protein percentage: Protein (%) = N (%) × 6.25 (Sadasivam & Manickam, 1996).

Crude Fat Determination

Crude fat content was estimated using the Soxhlet extraction method (AOAC 920.39) with petroleum ether as solvent. Fat content was calculated gravimetrically after solvent evaporation: Crude Fat (%) = (Weight of Extracted Fat / Sample Weight) × 100.

Crude Fiber Determination

Crude fiber was determined by sequential acid and alkali digestion of defatted samples (AOAC 962.09). Samples were boiled with 1.25% H₂SO₄ for 30 minutes, filtered, and the residue boiled with 1.25% NaOH. The residue was dried, weighed, and incinerated to obtain organic matter loss.

Carbohydrate Content

Total carbohydrate content was calculated by difference (Pomeranz & Meloan, 1994): Carbohydrates (%) = 100 – (Moisture + Ash + Protein + Fat + Fiber).

Statistical Analysis

All analyses were carried out in triplicate and the results expressed as mean ± standard deviation (SD). Statistical analysis was performed using SPSS version 22.0. One-way ANOVA followed by Tukey's post-hoc test was applied to determine significant differences ($p < 0.05$) among food groups.

RESULT AND DISCUSSION

Cereals, Millets, and Legumes

The proximate composition of cereals, millets, and legumes is presented in Table 2. Cereals and millets showed moderate moisture content (9.74–10.42%), indicating good storage stability at ambient conditions (Gupta et al., 2012). Carbohydrates constituted the major fraction in sorghum (71.96–72.52%) and pearl millet (68.84–69.46%), consistent with their role as primary energy sources for large populations (FAO, 2020; McKeivith, 2004).

Pearl millet exhibited higher protein (11.12–11.34%) and fat (4.72–4.86%) content compared to sorghum, making it nutritionally superior among cereals. These values are consistent with literature values reported by Boye et al. (2010). Kidney beans (L1) recorded exceptionally high protein content (22.4%), highlighting their importance as a protein source for vegetarian populations. The high fiber content of kidney beans (6.8%) further supports their established health benefits in glycemic control and cardiovascular risk reduction (Slavin, 2013).

Fruits and Vegetables

Table 3 presents the proximate composition of fruits and vegetables. All fruits and most vegetables exhibited high moisture content (77.52–90.12%), which explains their perishable nature and susceptibility to microbial spoilage (Jay, 2005).

Table 2. Proximate Composition of Cereals, Millets, and Legumes (g/100g, Mean ± SD)

Sample	Moisture	Ash	Protein	Fat	Fiber	Carbs
Sorghum (S1)	10.42±0.12	1.84±0.08	10.21±0.15	3.12±0.09	2.45±0.07	71.96
Sorghum (S2)	10.18±0.10	1.79±0.06	10.05±0.13	3.08±0.11	2.38±0.05	72.52
Pearl Millet (PM1)	9.86±0.14	2.12±0.09	11.34±0.18	4.86±0.12	2.98±0.08	68.84
Pearl Millet (PM2)	9.74±0.11	2.05±0.07	11.12±0.16	4.72±0.10	2.91±0.06	69.46
Kidney Beans (L1)	12.80±0.18	3.50±0.10	22.40±0.22	1.20±0.05	6.80±0.14	53.30
Peas (L2)	78.50±0.30	0.90±0.04	5.40±0.12	0.40±0.02	5.10±0.09	9.70

Table 3. Proximate Composition of Fruits and Vegetables (g/100g, Mean $\pm$ SD)

Sample	Moisture	Ash	Protein	Fat	Fiber	Carbs
Fig (F1)	79.84 $\pm$ 0.42	1.02 $\pm$ 0.05	1.24 $\pm$ 0.06	0.42 $\pm$ 0.02	2.92 $\pm$ 0.08	14.56
Sweet Lemon (F2)	86.75 $\pm$ 0.38	0.62 $\pm$ 0.03	0.86 $\pm$ 0.04	0.28 $\pm$ 0.01	1.84 $\pm$ 0.06	9.65
Guava (F3)	80.64 $\pm$ 0.35	0.95 $\pm$ 0.04	1.12 $\pm$ 0.05	0.35 $\pm$ 0.02	5.42 $\pm$ 0.12	11.52
Fenugreek (V1)	84.26 $\pm$ 0.29	1.98 $\pm$ 0.07	4.12 $\pm$ 0.10	0.92 $\pm$ 0.04	3.84 $\pm$ 0.09	4.88
Potato (V2)	77.52 $\pm$ 0.33	1.18 $\pm$ 0.05	2.14 $\pm$ 0.08	0.26 $\pm$ 0.01	1.62 $\pm$ 0.05	17.28
Cabbage (V3)	90.12 $\pm$ 0.40	0.84 $\pm$ 0.03	1.36 $\pm$ 0.06	0.18 $\pm$ 0.01	2.42 $\pm$ 0.07	5.08

Table 4. Proximate Composition of Spices (g/100g, Mean $\pm$ SD)

Sample	Moisture	Ash	Protein	Fat	Fiber	Carbs
Cinnamon (SP1)	11.28 $\pm$ 0.16	4.36 $\pm$ 0.11	3.88 $\pm$ 0.09	1.24 $\pm$ 0.05	5.62 $\pm$ 0.10	73.62
Nutmeg (SP2)	9.84 $\pm$ 0.12	3.12 $\pm$ 0.08	5.96 $\pm$ 0.14	36.42 $\pm$ 0.80	8.18 $\pm$ 0.18	36.48
Clove (SP3)	8.62 $\pm$ 0.10	5.84 $\pm$ 0.13	6.02 $\pm$ 0.15	19.38 $\pm$ 0.60	10.12 $\pm$ 0.22	50.02
Black Pepper (SP4)	10.46 $\pm$ 0.13	4.92 $\pm$ 0.10	10.42 $\pm$ 0.17	3.26 $\pm$ 0.08	11.08 $\pm$ 0.24	59.86

Sweet lemon (F2) recorded the highest moisture content (86.75%), while cabbage had the highest among vegetables (90.12%).

Guava (F3) showed significantly higher fiber content (5.42%) compared to other fruits, supporting its established role in improving digestive health and regulating blood glucose levels (WHO, 2021). Fenugreek leaves (V1) had the highest protein content among vegetables (4.12%) and considerable ash content (1.98%), indicating a rich mineral profile. Potato (V2) had higher carbohydrate content (17.28%) consistent with its starchy nature. Low fat content across all fruits and vegetables (0.18–0.92%) reflects their suitability for low-fat dietary regimens.

Spices

The proximate composition of spices is summarized in Table 4. Spices showed consistently low moisture content (8.62–11.28%), explaining their superior storage stability and long shelf life (Peter, 2012). The elevated ash content in spices—particularly clove (5.84%) and black pepper (4.92%)—reflects their rich mineral composition, including calcium, potassium, iron, and magnesium, which contribute to their nutritional and pharmacological significance. Nutmeg (SP2) recorded exceptionally high fat content (36.42%), primarily comprising myristicin and other volatile essential oils. Clove (SP3) and cinnamon (SP1) had notable fiber content (10.12% and 5.62%, respectively), contributing to their function in

digestive health. Black pepper demonstrated the highest fiber content (11.08%) among all spices, consistent with reported values in literature (Ranganna, 1986). These concentrated nutritional characteristics confirm the health-promoting properties of spices beyond mere flavoring agents.

Comparative Analysis Across Food Groups

Comparative analysis across the five food categories revealed distinct nutritional fingerprints. Legumes, particularly kidney beans, emerged as the richest protein source (22.4%), far exceeding other food groups. Spices and cereals dominated in carbohydrate concentration when analyzed on a dry-weight basis. Moisture content followed the gradient: vegetables > fruits > legumes (fresh peas) > cereals/spices. Dietary fiber was highest in spices (black pepper, 11.08%), followed by legumes and guava, underscoring the importance of dietary diversity.

These observations align with the findings of Kirk and Sawyer (1991) and James (1995), who reported similar compositional trends. The variation in fat content was notably large—from 0.18% in cabbage to 36.42% in nutmeg—highlighting the critical importance of food-specific analysis rather than reliance on generalized nutritional databases (Pomeranz & Meloan, 1994). The data generated are particularly valuable for formulation of balanced diets, development of functional foods, and nutritional labeling compliance.

CONCLUSION

The present study successfully determined the proximate composition of fourteen food samples representing five dietary categories using validated AOAC standard methods. Significant variation in nutritional composition was demonstrated across and within food groups. Cereals and millets serve as major energy and carbohydrate sources, legumes are outstanding protein contributors, fruits and vegetables provide essential moisture and dietary fiber, and spices offer concentrated minerals and bioactive compounds with superior shelf stability.

Pearl millet and kidney beans emerged as nutritionally superior within their respective categories. Nutmeg recorded the highest fat content, and black pepper the highest fiber content among spices. Guava distinguished itself among fruits for its fiber richness. These findings offer a reliable baseline for nutritional evaluation, food quality control, dietary planning, and future studies including detailed micronutrient profiling, antioxidant activity assessment, and food preservation research.

Author contributions

Naushad Anjum: Conceptualization, experimental design, laboratory analysis, data collection, writing – original draft. Rizwan Shaikh: Methodology, statistical analysis, validation, writing – review and editing. Both authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no competing interests.

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