Canrea Journal: Food Technology, Nutritions, and Culinary, 2025; 8 (2): 326–342 OPEN ACCESS

e-ISSN : 2621-9468

Type of the Paper (Article)

Physicochemical and microbiological analysis of common spices available in Bangladesh

Abdullah Jubair[1], Md. Murad Hossain[1], Wahidu Zzaman[1], Erni Sofia Murtini[2], and Nurul Huda[3*]

[1] Department of Food Engineering and Tea Technology, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh
[2] Faculty of Agricultural Technology, Universitas Brawijaya, Malang 65145, East Java, Indonesia
[3] Postgraduate School, Universitas Brawijaya, Malang 65145, East Java, Indonesia

Abstract

This study aimed to assess nutritional composition, quality attributes and microbial load of different variety of turmeric (*Curcuma longa*), chili (*Casicum annuum*) and coriander (*Coriandrum sativum*) collected from different region of Bangladesh during April to October, 2023. Ash content in different spice ranged from 6.07% to 12.03% and protein ranged from 3.27% to 13.20%. Chili had the highest protein and coriander had the lowest. Chili contain more fat (17.21% to 20.21%) than turmeric (0.05% to 12.08%) and coriander (11.21% to 13.04%). In different varieties of chili capsaicin content, the American Trade Association (ASTA) color value and Scoville Heat Unit (SHU) values differed significantly between 0.08% to 0.32%, ASTA 58.1 to ASTA 74.25 and SHU 13000 to SHU 51000 respectively. In terms of analyzing curcumin content and color value of different varieties of turmeric, ranged from 1.98% to 3.02% and 33.26 to 50.74. In case of analyzing microbiological analysis of different spices, the total plate count (TPC) was found ranging from 3200 to 67000 where lowest TPC was found in turmeric (3200 to 8300). *Salmonella spp.* was detected in one sample of coriander. Nutritional composition, quality attributes and microbial load provide useful information for people who want to buy spices from other countries and for industrial use.

Article History
Received May 13, 2025
Accepted October 21, 2025
Published December 2, 2025

Keywords
Spices, Protein, Capsaicin, TPC, *Salmonella spp.*, Quality Analysis.

1. Introduction

Throughout history, people have traditionally used functional foods for a variety of purposes (1), and spices are one of them. Spices are specific types of vegetables, seeds, roots, or even bark normally used for the purpose of developing taste, color, aroma, etc. For preserving food, different types of spices are also used. The spices are used for a variety of purposes while producing medicines, cosmetics, or perfumes. Some spices are also used as raw vegetables in many parts of the world (2).

Spices are considered very crucial crops as food and also as medicine. But in fact, spices are generally used for cooking purposes and also for seasoning foods. Besides, spices are also used for the purpose of changing the flavor of the food and the external appearance so that the food becomes more attractive and also in color. So, it is quite clear that spices can also act as the things that create more attractions in food items. In ancient times, many people were habituated to using the spices in different types of curries and in other food menus. At present, many people have been using the spices of various kinds to make delicious foods and

* Correspondence : **Nurul Huda** drnurulhuda@ub.ac.id

ISSN 2621-9468 online, DOI 10.20956/canrea.v8i2.1838

curries for their personal or occasional users. Most of the curries and menus are made tasty using the combination of different spices in various parts of the world. Spice fortification of dairy products may aid in the provision of useful dairy products with therapeutic and nutritional benefits (3).

Coronary heart disease is an alarming global health concern characterized by inflammation and the progression of fatty deposits in the coronary arteries (4). Spices have certain medicinal properties; for example, turmeric helps lower blood sugar, garlic helps maintain memory and eliminate heart disease, and ginger is known for its digestive properties. Chili has shifting health benefits, consisting of anticancer, anti-inflammatory, anti-neoplastic, antiarthritic, antifungal, and antioxidant properties (5). Spices and condiments play a particularly important role in the national economy of various spice-producing countries, importing countries, and exporting countries of the world. Of the 109 types of spices that are currently grown worldwide, only 27 are used, and 17 are produced in Bangladesh. According to the area, production, demand, and availability, spices are divided into three categories: major, minor, and exotic. The main spices that are often used in enormous quantities in the daily diet are pepper, onion, garlic, turmeric, and ginger (6).

Bangladesh has a cultivated area of 3.96 million hectares of spices with an annual production of 24.88 million tons and an annual demand for spice seeds of 300,000 metric tons. Spices make up almost 2.60% of Bangladesh's total agricultural land. Recently, the production of major spices such as onions, garlic, chili peppers, turmeric, and ginger is 17.35, 3.82, 1.30, 1.40, and 0.77 million tons, respectively. The average market prices per ton of major spices are as follows: onion 27,180 taka, garlic 110,910 taka, chili 195,990 taka, ginger 74,490 taka, and turmeric 275,850 taka. Significant amounts of spices are imported each year at the expense of foreign currency to meet the huge demand of the people. The import prices per ton of major spices are as follows: onion 19,300 taka, garlic 163,980 taka, and ginger 64,460 taka (6).

Chili quality and commercial value are largely determined by pungency, color value and sensory, which are determined by SHU value ASTA colorand oil fractions (7,8). Scoville Heat Units (SHU) reflect capsaicin content, defining pungency and market preference, with higher SHU varieties commanding premium prices. ASTA color value measures carotenoids and visual appeal, critical for trade competitiveness. Non-volatile ether extract indicates retention of capsaicinoids and pigments, vital for oleoresin and spice industries. Volatile oils, though smaller in quantity, impart a distinctive aroma, enhancing consumer acceptability. Together, these parameters influence quality grading, internal market value, and international demand, making their monitoring essential for commercial success (8,9). In Bangladesh, several studies have been conducted on the proximate analysis and microbiological analysis of different spices (10–12). However, the major quality parameters with the highest commercial value — such as color and pungency (SHU and ASTA color value of chili, and curcumin and color value of turmeric) — still need to be determined.

Pabna and Bogura are long-recognized hubs for turmeric cultivation and supply significant volumes to domestic markets. Khagrachari and Chittagong represent the hill tracts and coastal regions, where unique local varieties of turmeric and chili, such as Hill Anju, Hill Banu, and Hathajari are cultivated. Faridpur and Pabna are also important coriander-producing areas, contributing substantially to local and regional trade. By targeting these districts, the study ensured inclusion of both high-production centers and diverse agro-

ecological conditions, providing a representative overview of the nutritional and microbiological quality of spices in Bangladesh.

The purpose of this study was to analyze the proximate composition and microbial analysis of dried chili (*Capsicum annuum*), turmeric (*Curcuma longa*) and coriander (*Coriandrum sativum*) and to analyze the active ingredients (capsaicin content) and turmeric (curcumin content) of chili peppers and to grasp the current state of commercial market value of chili peppers (ASTA color value and SHU value) and turmeric (color value) quality evaluation.

2. Materials and Methods

2.1. Material Collection

Materials of the experiment are commercial dried chili (*Capsicum annuum*), turmeric (*Curcuma longa*), and coriander (*Coriandrum sativum*). Turmeric collected from the area of Pabna, Bogura, Khagrachari; Chili collected from Chittagong, and coriander collected from the area of Faridpur and Pabna (Figure 1). Turmeric (moisture content below 12%) was taken after conducting the main processing (washing and drying), whereas the Chili (moisture content was around 15%) was collected after the drying process. These areas were chosen to collect spices of various varieties (Table 1). Different varieties of turmeric and Chili are shown in Table 2.

Figure 1. Material collection area (Indicated by a red mark) in Bangladesh.

Table 1. Sample size, collection, and product description.

Sample Name	Local Variety name	Collection Area	Code Name
Turmeric (*Curcuma longa*)	Mura	Pabna	TMP
	Mura	Bogura	TMB
	Chora	Bogura	TCB
	Hill Anju	Khagrachari	TAK
	Hill Anju	Chittagong	TAC
	Hill Banu	Chittagong	TBC

Chili (*Casicum annuum*)	Tatai	Bogura	CTTB
	Teja	Bogura	CTJB
	Teja	Bogura	CTJB1
	Hathajari	Chittagong	CHC1
	Hathajari	Chittagong	CHC2
	Hathajari	Chittagong	CHC3
Coriander (*Coriandrum sativum*)	Samti	Faridpur	CoSF1
	Samti	Faridpur	CoSF2
	Samti	Faridpur	CoSF3
	Raki	Pabna	CoRP1
	Raki	Pabna	CoRP2
	Raki	Pabna	CoRP3

Table 2. Appearance of turmeric and chili varieties.

Sample	Variety			
Turmeric	Mura (TMP)	Chora (TCB)	Hill Anju (TAK)	Hill Banu (TBC)
				
Chili	Tatai (CTTB)	Teja (CTJB)	Hathajari (CHC1)	
				

2.2. Physicochemical Analysis

2.2.1. Moisture Content

The sample grounded was ground through 1.0 mm sieve. 5 g sample was weighed in a properly dried dish, and dish was placed with its lid in the oven for 2 hours at 130 °C. After performing cooling in the desiccator, the weight was measured. The dish was backed in the oven at around half-hour intervals till the constant weight was successfully achieved. Then the moisture content was measured using equation (1), where W1 is the weight of the dish with the sample before drying, W2 is the weight of the dish with the sample after drying, and W is the weight of the empty dish. All weights are measured in grams unit (13).

$$\text{Moisture } (\%) = \frac{(W2-2)}{(W1-W)} \times 100 \quad (1)$$

2.2.2. Ash Content

Ash content was determined by using a muffle furnace (14). The sample was grounded and sieving was properly done by using a 500 µm mesh size. A 2 g sample was measured into a silica dish, which was then treated by suitable drying. 2 ml of ethanol was poured on the selected sample, and ignition at around 800 °C on an induction plate was done. After burning off the ethanol, the dish was properly ignited in a muffle furnace at around 650 °C for almost 4 hours. Cooling was done in the desiccator. The sample was then wetted with some drops of water. Evaporation was done at around 200 °C with a hot plate. Heating was done in a muffle furnace once again at around 5500 °C for almost an hour. After showing the ash to the carbon carbon-free, the dish was then transferred to the desiccator for cooling. After cooling, the weight was taken without any delay. Ignition was then done once again for an hour; cooling and weighting was done again till the measured difference in weight between two successive weighting was less than 0.001 g. The lowest weight was then recorded, and then ash content was measured using equation (2), where W is the weight of the empty dish, W1 is the weight of the dish and sample, and M is the percent of moisture.

$$\text{Total ash on (dry basis)\% by wt} = \frac{(W2-W)}{W1-W} \times 100 \times \frac{100}{100-M} \quad (2)$$

2.2.3. Acid Insoluble Ash

For determining the acid-insoluble ash, 25 ml of dilute HCl was firstly added to the dish involving total ash (15). The boiling process was performed on the water bath. Cooling was done and the associated content of the dish through ash less filter paper (80 micron). Filter paper was then washed with hot water until the entire washing was free from HCl as tested by the methylene blue indicator. The evaporation was done on the hot water bath, and ignition was successfully done in a muffle furnace at around 550 ± 25 °C for an hour. Dish was then cooled in a chemical desiccator and weighed. Ignition was done once again for around an hour, cooling and the weighting was done again till the measured difference in the weight between two weighting was less around 0.001 g. Lowest weight was also recorded and acid insoluble ash amount was calculated using the equation below, where W is the weight of empty dish, W1 is the weight of dish and sample, W3 is the weight of dish + acid-insoluble ash and M is percent of moisture.

$$\text{Ash insoluble in diluted HCl (on dry basis) \% by wt} = \frac{(W4-W)}{(W1-W)} \times 100 \times \frac{100}{100-M} \quad (3)$$

2.2.4. Crude Fiber

For measuring the crude fiber of the samples, around 2.5 g of ground sample was selected into a specific thimble and was afterwards extracted for about an hour with petroleum ether in the Soxhlet extractor (16). The material was then transferred in another thimble to a 1-liter flask. Around 200 ml diluted sulfuric acid was filled in a beaker and has to boil. The boiling acid was then transferred to the flask containing the fat free material and flask was joined to a water-cooled reflux condenser for around 30 minutes. Flask was then removed, and filtering was complete through fine linen. The washing procedure was done using the boiling water until the washings are no longer acid to methyl orange. The residue was washed seamlessly first with the use of hot water and then with around 15 mL of ethanol and with 3 washings of petroleum ether. The dried crucible was measured. The selected

sample was taken in a crucible and was then burnt in the muffle furnace at around 550 ± 25 °C. The burning procedure was performed until all the carbonaceous matter was successfully burnt. After cooling, the crucible was measured and the following equation was applied were W1 is the weight of crucible, sample and asbestos before ashing, W2 is the weight of the crucible, ash, and asbestos after ashing, W is the sample weight M is percent of moisture.

$$\text{Crude Fiber (on dry basis)} = 100\times \frac{W1-W2}{W} \times \frac{100}{W(100-M)} \quad (4)$$

2.2.5. Protein

The proportion of the protein was measured according to (16). The amount of nitrogen was calculated, and the protein amount was derived by multiplying by a factor of 6.25. In the given equation, Ts is the Titre volume of the sample (ml), Tb is the titre volume of the blank (ml), and 0.014= M eq. of N2.

$$\%\ \text{Nitrogen} = \frac{Ts-Tb \times \text{Normality of Acid}}{\text{Weight of sample}} \times 100 \quad (5)$$

$$\%\ \text{Protein} = \text{Nitrogen} \times 6.25 \quad (6)$$

2.2.6. Non-Volatile Ether Extract

Around 2 g of ground sample was included in a thimble. The sample was then extracted in an extraction apparatus or Soxhlet extractor with diethyl ether for around 18 hours. The extraction procedure was done until the suitable color of ether was completely clear in the Siphon tube. The drying is done until the difference in two weight is less than around 2 g. The lowest weight was recorded as well (16). The nonvolatile ether extract amount was calculated using equation (7), where W1 is the weight of the flask with Nonvolatile extract, W2 is the weight of the flask with ether in soluble residue after decantation, and W is the weight of the sample taken for the test.

$$\text{Non-volatile ether extract (\% by weight)} = \frac{100\ (W1-W2)}{W} \quad (7)$$

2.2.7. Volatile Oil

The ground sample was passed around an 850-micron sieve. Around 50 g of sample was measured and placed in the flask with glass beads. Around 300 ml of water was included. The trap was filled with water. Water cooled condenser was set with the trap. The distillation was done until the two consecutive readings were taken at around 1-hour intervals. No change was observed in the oil content. Xylene was used, and the volume was calculated, including the xylene which was segregated for density difference. Xylene was then subtracted from the measured volume (16).

2.2.8. Capsaicin

The extract was first prepared employing the Soxhlet extraction method according to (17). About 5 g of the dried chili powder material was packed into a thimble and then extracted using the Tetra Hydro Furan. The entire procedure of extraction continues for about 24 hours or till the solvent in the siphon tube of the extractor becomes colorless. After that, the extract was taken in a beaker and kept on a hot plate and heated at around 30-40 °C till

all the selected solvent were properly evaporated. Dried extract was then kept in the refrigerator at around 4 °C for future use in the Capsaicin analysis. The concentration of capsaicin in the extracts was measured using their absorbencies calculated at λ=280nm. A simple linear regression curve was also used plotted using standard capsaicin. A calibration curve was prepared with capsaicin standards 0.05–0.50 mg/mL, where r^2=0.986.

$$\text{SHU value} = 16 \times 10000 \times \text{Capsaicin Content} \quad (8)$$

2.2.9. ASTA Color Value of Chili

For measuring the ASTA Color Value of chili, according to (5), the samples were grounded and passed through the 500-micron sieve. 70-100 mg of each sample was measured in a 100 ml volumetric flask. The entire dilution was done with the use of acetone. After proper shaking, it was kept in the dark for around 16 hours. The upper portion of the extract was then transmitted to the spectrophotometer cell. The absorbance was determined at around 460 nm, using acetone as a blank and the absorbance was taken of NIST standard at around 465 nm. Equations (9) and (10) were followed to calculate the color values, where 16.4 is a conversion factor according to American Trade Association (ASTA) color values.

$$\text{ASTA color value for capsicum} = \frac{\text{A extract at 460 nm x 16.4x If}}{\text{Weight of the sample}} \quad (9)$$

Where 16.4 are conversion factors to American Trade Association (ASTA) color values. Correction factor, I_f = declared Absorbance of NIST standard at 465 nm / actual absorbance of NIST standard at 465 nm.

2.2.10. Curcumin Content and Color Value of Turmeric

Around 0.1 g of turmeric was taken in a chemical beaker containing around 70 ml of ethanol. After effectively mixing using a magnetic stirrer at around 850 rpm, about 10 ml of the solution was taken into a 100 ml volumetric flask, and the dilution was done to mark the volumetric flask with ethanol. The sample was taken in 1 cm cell, and the absorbance of the extract was calculated at around 425 nm (5). The parameters were measured using equations (10), (11), and (12) where a is the absorbance of the sample at 425 nm, I is the cell length in cm, and m is the mass of the sample in grams.

$$\text{Curcumin Content} = \frac{\text{a x 100}}{\text{I x A x m}} \quad (10)$$

$$\text{Color Value} = \text{a x 1000} \quad (11)$$

$$\text{A = Absorbency} = \left(\frac{0.42}{l \times 0.0025}\right) \quad (12)$$

2.3. Microbiological Analysis

2.3.1. Total Plate Count (TPC)

A 25 g sample was taken in 225 ml BPW. Serial dilution was done. PDA was used as the nutrient media. Incubation was done at 37 °C for 72 hours (18).

2.3.2. *Salmonella spp.*

Around 25 g of sample was used in 225 ml Buffered Peptone Water, and the incubation procedure was done at around 37 °C for about 24 hours. Then the Fluid Selenite Cystine Broth was utilized as enrichment media and was incubated at 37 °C for about 24 hours. Then, the

sticking was properly done in the semi-solid Salmonella Shigella (SS) Agar and was then incubated at around 37 °C for about 24 hours. When there's dark centre color is found, Triple Sugan Iron (TSI) Slut was used (18).

2.4. Statistical Analysis

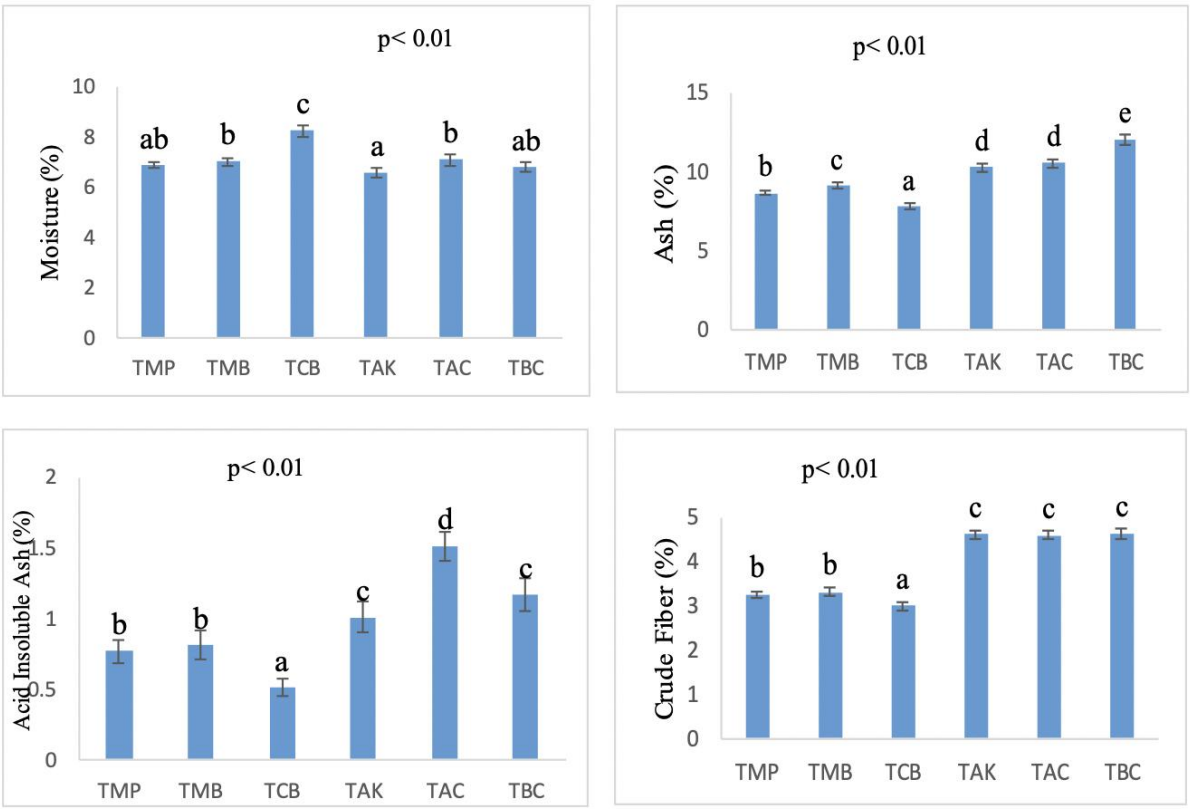
Data were recorded and analyzed using Microsoft Excel (version 2016) and IBM SPSS Statistics (version 26.0). One-way analysis of variance (ANOVA) was conducted to assess the significance of differences across various parameters among different varieties within distinct species. Post hoc comparisons were performed using Duncan's Multiple Range Test (DMRT), with statistical significance set at $p < 0.05$.

3. Results and Discussion

3.1. Physicochemical Analysis

3.1.1. Turmeric

In case of the turmeric procedure, a certain amount of moisture was found which was around 6.57 % to 8.25 % (Figure 2). The ash content ranged from approximately 7.75% to 12.03%. Acid-insoluble matter was between 0.5% and 1.51%, while crude fibre ranged from 2.9% to 4.61%. The amount of protein was around 8.2% to 13%. For the Chittagong chili sample, the moisture content, ash, and the acid insoluble ash were found much higher compared to the other samples found in other districts (19). Lahari et al. stated that the moisture (db) from two different procedures i.e., non-cured and cured, was 14.48% and 14.60%, respectively (20). The curcumin content obtained from the non-cured and cured samples was 2.82% and 3.12%, respectively (20). Mane et. al., found that the moisture content was 84.25%, carbohydrate 9.10%, protein 1.20% and fat 1.08% respectively (21).



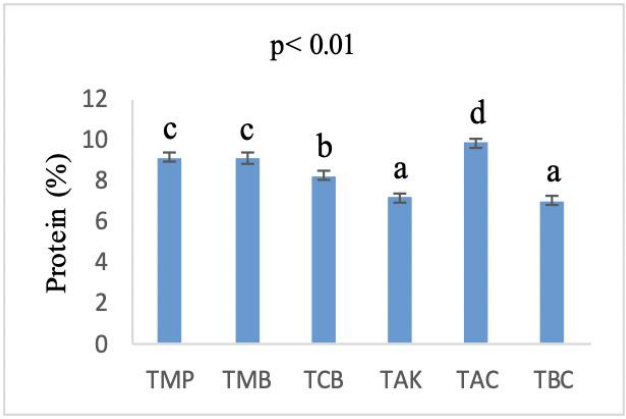
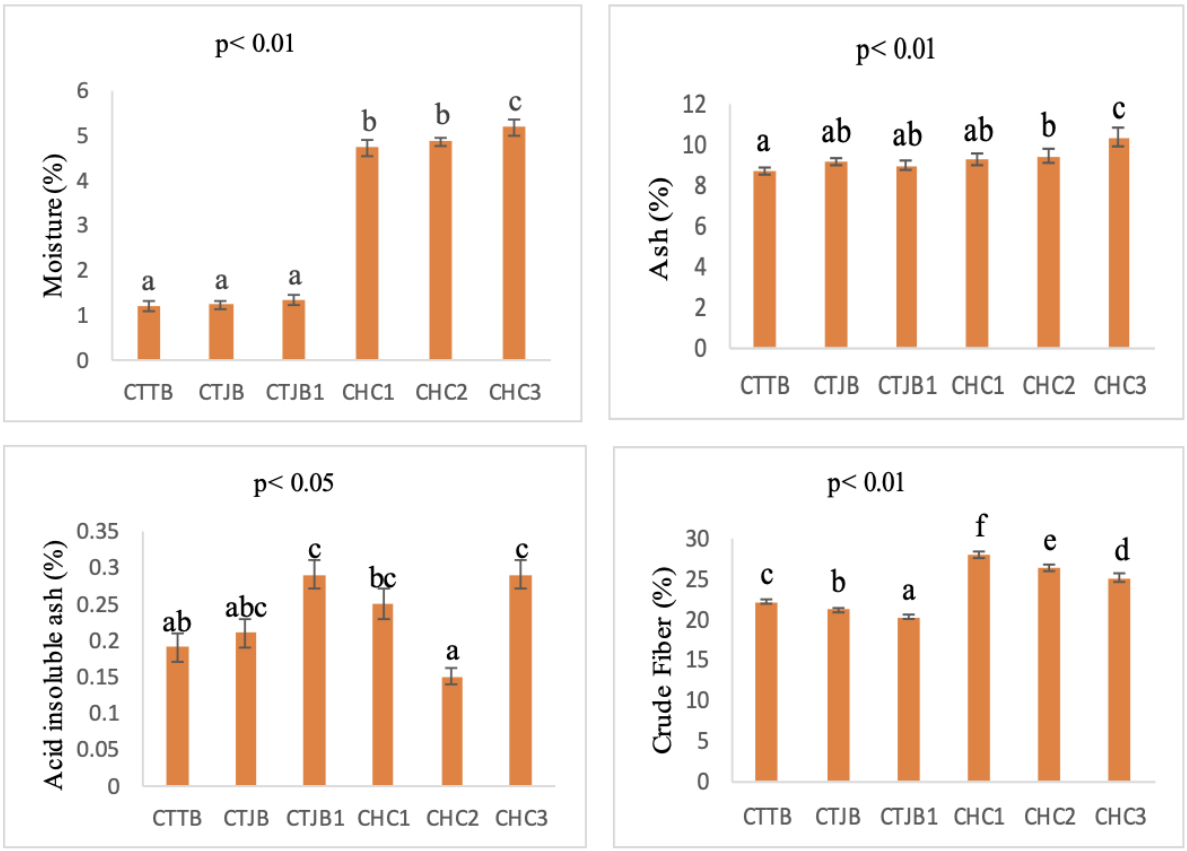


Figure 2. Physiochemical analysis of different varieties of turmeric (n=6). The turmeric variety codes are as follows: TMP, TMB, TCB, TAK, TAC, and TBC.

3.1.2. Chili

The moisture content of chili ranged from 1.19% to 5.17%. Ash content was between 8.73% and 10%. Acid-insoluble ash ranged from 0.15% to 0.29%, while crude fibre content ranged from 21.19% to 27.93% (Figure 3). The amount of protein found in the sample was around 19.05 percent to 24.03%. A significant difference was observed in the parameters among the various varieties, as well as across different collection areas. Another study found that the amount was 8.2% of moisture, 11.2% of protein, and 33.17% of crude fibre in chili (22). A study conducted in Bangladesh found around 5.28% to 5.95% ash and 1.3 to 1.4% acid-insoluble ash (23).



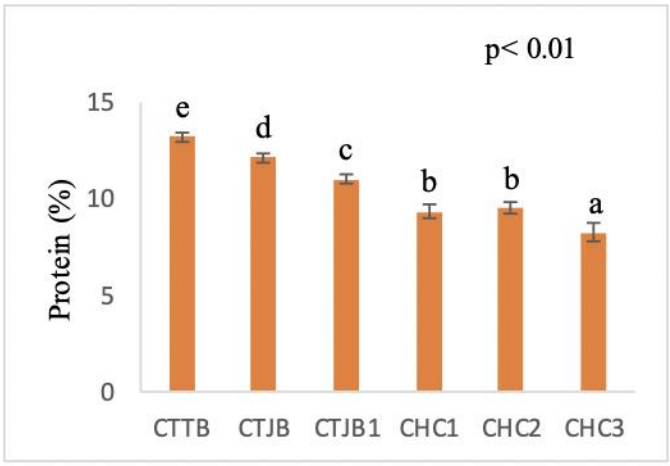
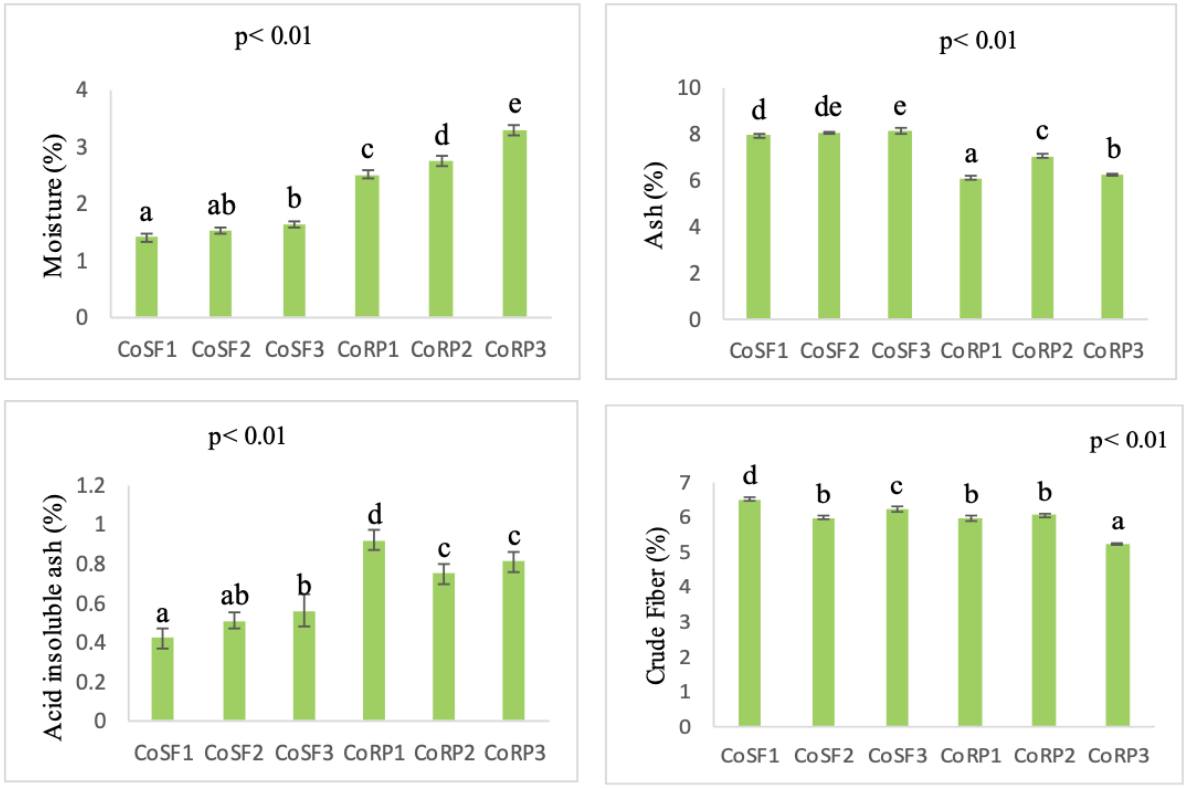


Figure 3. Physiochemical analysis of different varieties of chili (n=6). The chili variety codes are as follows: CTTB, CTJB, CTJB1, CHC1, CHC2, and CHC3.

3.1.3. Coriander

In the coriander samples, the moisture content ranged from 1.4% to 3.3%. Ash content was between 6.07% and 8.1%, while acid-insoluble ash ranged from 0.42% to 0.92%. Crude fibre content was 5.22% to 6.52%. A small amount of protein was also detected (Figure 4).



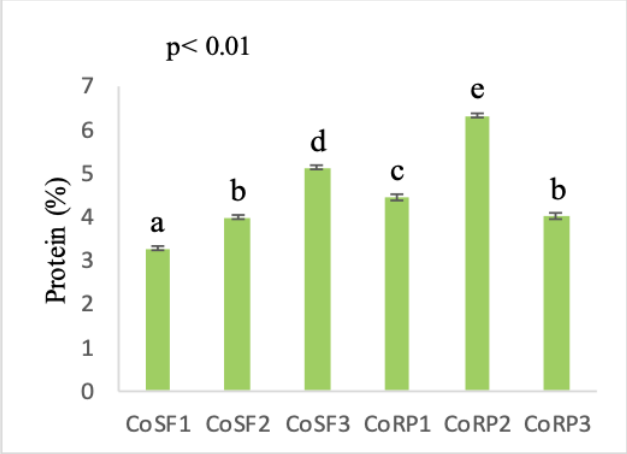


Figure 4. Physiochemical analysis of different varieties of coriander (n=6). The coriander variety codes are as follows: CoSF1, CoSF2, CoSF3, CoRP1, CoRP2, and CoRP3.

A study Syahwar et al. (24) on proximate analysis of coriander leaves and seeds found higher moisture content in leaves (86.71 ± 0.11%), while lower moisture content was found in seeds (6.2 ± 0.10%). The same study also demonstrated that seeds of coriander contain more crude fat (9.12 ± 0.09%) and protein (12.58 ± 0.77%) comparing with leaves, which contain crude fat 0.95 ± 0.01% and protein 4.05 ± 0.21%. In addition, crude fiber of coriander leaves is 5.24 ± 0.23% which is lower than the seed of coriander (37.14 ± 0.07%) (24). Another study found 84.98% of moisture in coriander puree (25). In a study, seed moisture was found 6.65% (26). According to other researchers' results, crude protein of coriander seeds was found 11.75% and crude fat of coriander seeds was 9.8% (26). In other study 13.76% crude protein and 25.01% crude fiber were found in coriander seeds (27). Another group of scientists found that leaves of coriander have 3.3% protein content and 1.2% fat content (28).

3.2. Non-Volatile Ether Extract and Volatile Oil

The amount of non-volatile ether extract found was around 10.05% to 12.07% among the turmeric sample (Table 3). The non-volatile ether extract content ranged from 17.1% to 20.21% in chili samples and from 11.1% to 13.03% in coriander samples. Various types of volatile oils were also detected in turmeric, ranging from 1.31% to 4.89%. In chili and coriander, volatile oil content was 1.50 % to 1.71% and 0.72% to 1.15%, respectively. It was also found that the turmeric collected from the Chittagong area had lower volatile oil compared to the other samples. The non-volatile ether extract content was found to be higher in the chili sample compared with the turmeric and the coriander samples. In another research study, it was found that the amount of fat was around 5.06% (20). Another study on non-dried chili, around 1.08% was found in terms of fat content (21). In both cases, the moisture was more than 80%.

Table 3. Non-volatile ether extract and volatile oil of different varieties of turmeric.

Code Name of Sample	Non-Volatile Ether Extract / Fat (%)	Volatile Oil (%)
TMP	11.74 ± 0.32^{c}	4.64 ± 0.10^{d}
TMB	12.08 ± 0.38^{c}	4.89 ± 0.12^{e}
TCB	11.79 ± 0.28^{c}	4.75 ± 0.08^{d}

Code Name of Sample	Non-Volatile Ether Extract / Fat (%)	Volatile Oil (%)
TAK	10.73±0.29^{b}	1.50±0.03^{b}
TAC	11.72±0.26^{c}	1.72±0.02^{c}
TBC	10.05±0.23^{a}	1.31±0.02^{a}
CTTB	19.27±0.31^{c}	1.60±0.03^{b}
CTJB	20.21±0.19^{d}	1.71±0.02^{c}
CTJB1	20.15±0.21^{d}	1.50±0.02^{a}
CHC1	17.21±0.18^{a}	1.70±0.02^{c}
CHC2	18.26±0.23^{b}	1.62±0.03^{b}
CHC3	19.87±0.25^{d}	1.58±0.03^{b}
CoSF1	12.14±0.26^{b}	0.76±0.01^{c}
CoSF2	13.04±0.34^{c}	0.72±0.01^{b}
CoSF3	11.87±0.42^{ab}	0.69±0.01^{a}
CoRP1	11.21±0.26^{a}	1.10±0.02^{e}
CoRP2	12.05±0.46^{b}	1.15±0.02^{f}
CoRP3	11.75±0.39^{ab}	1.05±0.01^{d}

Values are presented as mean ± standard deviation (n=6). Values within the same column followed by different superscripts are significantly different, at $p < 0.05$.

3.3. Quality Analysis of Chili

In terms of the quality analysis of the chili (Table 4), capsaicin was found, amounting 0.08% to 0.32%. As far as the Chittagong chili is concerned, more capsaicin content was found. Scoville Heat Unit (SHU) was found around 13000 SHU to 51000 SHU. As far as the Chittagong chili is concerned, more SHU content was found. The ASTA color value was found around 58.1 to around 74.25. Another research study on the dried chili in India found capsaicin to around 1128 µg/g to 25944 ug/g and found SHU value 20304 SHU to around 466992 SHU (29). A study on 52 chili samples got ASTA values of 48 ASTA to 160 ASTA (29).

Table 4. Different quality analysis of chili varieties.

Variety Name	Code Name	Capsaicin (%) (mean values)	SHU (mean values)	ASTA Color (mean values)
Tatai	CTTB	0.19^{c}	30000^{c}	64.3^{b}
L.Teja	CTJB	0.08^{a}	13000^{a}	70.2^{c}
L.Teja	CTJB1	0.11^{b}	17000^{b}	58.1^{a}
Hathajari	CHC1	0.25^{d}	40000^{d}	74.25^{d}
Hathajari	CHC2	0.31^{e}	49000^{e}	69.15^{c}
Hathajari	CHC3	0.32^{e}	51000^{e}	62.18^{b}

Values within the same column followed by different superscripts are significantly different at $p < 0.05$.

The capsaicinoids are generally responsible for the functionality of chilies. Capsaicin (N-Vanillyl-8-methyl-6-(E)-noneamide) is represented with around 69% in the group of capsaicinoids; dihydrocapsaicinoids with almost 22%; nor-dihydrocapsaicinoids with around 7%; homocapsaicin and homo-hydro capsaicin takes merely 1% in the group of the capsaicinoids. The capsaicin and dihydrocapsaicin ingredients have anti-cancer, simulative, and carminative characteristics. The capsaicin ingredient is a vanilloid type and one of the

heaviest categories of compounds found in nature. The ratio of two ranges in terms of ratio is 1:1 to 2:1. The capsaicin content in the chili pepper (Bhut Jolokia) was comparatively higher than any other type of Indian chili (30).

The chili pepper is also considered a prime source of vitamins A, B, C, along with potassium, magnesium, and iron (31). The ripening step was signified by the red color of chili is due to the presence of carotenoids, various types of tocopherols, capsaicinoids, and the ascorbic acid. So the variation in color suggests the associated declination in these alkaloid ingredients in chili (32). In a previous study, the capsaicinoid content of various fermented Chinese chili (1.59-4.94 mg/g) was found (33). Variation in amount of capsaicinoid has been found due to genotype, environmental conditions, and fruit development. The average SHU of various fermented Chinese chili was reported to be 35,250-134,863 (33). Chillies are categorised according to their pungency levels: mild (900–1,995 SHU), medium (2,010–19,995 SHU), hot (19,995–99,000 SHU), and extra hot (> 99,000 SHU) (34).

3.4. Quality Analysis of Turmeric

Curcuminoids are well known as curcumin, the main phytoconstides found in about 16% by dry weight as diarylheptanoids (35), and is responsible for the light color of curcuma. Curcumin was found at around 1.98% to 3.02% in the turmeric samples. In terms of color Value, 33.26 to 50.74 was found in Table 5. More curcumin content was found in the Bogura chili. A research study found curcumin at around 3.44% to 4.12% in a turmeric sample (21). Another research study found around 3.12% curcumin (20). The table below shows different quality attributes found in the turmeric samples.

Table 5. Different quality analysis of turmeric varieties.

Turmeric Variety	Code Name	Curcumin (%) (mean values)	Color Value (mean values)
Mura	TMP	2.63%^{c}	44.18^{c}
Mura	TMB	3.02%^{e}	50.74^{d}
Chora	TCB	2.79%^{d}	46.87^{c}
Hill Anju	TAK	2.05%^{a}	34.44^{a}
Hill Anju	TAC	1.98%^{a}	33.26^{a}
Hill Banu	TBC	2.13%^{b}	35.78^{b}

Values within the same column followed by different superscripts are significantly different, at $p < 0.05$.

3.5. Microbial Analysis

The total plate count was found around 4.2 x 10^3 cfu/g to around 8.3 x 10^3 cfu/g in the turmeric sample (Table 6), 3.1 x 10^4 cfu/g to around 6.7 x 10^4 cfu/g in the chili sample, and 3.5 x 10^4 cfu/g to 6.2 x 10^4 cfu/g in the coriander sample. A certain amount of lower microbial load was also found in turmeric samples compared with chili and coriander samples. A research study done on turmeric found around 10 x 10^5 count/g and found *Salmonella spp.* absent in the 25 g (36). Another research study on chili found 2.3 x 10^3 cfu/g to 5.7 x 10^3 cfu/g on total plate count and found the *Salmonella spp.* content absent in 25 g in all the selected samples (23). Besides, *Salmonella spp.* was also found only in one of the coriander samples. Probable sources of *Salmonella* contamination in coriander include irrigation water contaminated with livestock feces and post-harvest exposure to rodent (rat) stool during storage and handling.

Table 6. Microbial analysis of different varieties of Spices.

Code Name of Spices Variety	Total Plate Count (cfu/g)	*Salmonella spp.*/25gm
TMP	$4.2 \times 10^3 \pm 10.89^b$	Absent
TMB	$7.1 \times 10^3 \pm 8.34^e$	Absent
TCB	$5.7 \times 10^3 \pm 7.89^d$	Absent
TAK	$3.2 \times 10^3 \pm 3.46^a$	Absent
TAC	$8.3 \times 10^3 \pm 2.45^f$	Absent
TBC	$4.5 \times 10^3 \pm 2.54^c$	Absent
CTTB	$3.1 \times 10^4 \pm 5.67^a$	Absent
CTJB	$4.5 \times 10^4 \pm 4.65^b$	Absent
CTJB1	$5.2 \times 10^4 \pm 4.23^d$	Absent
CHC1	$4.9 \times 10^4 \pm 5.42^c$	Absent
CHC2	$6.7 \times 10^4 \pm 6.73^f$	Absent
CHC3	$6.3 \times 10^4 \pm 5.87^e$	Absent
CoSF1	$3.5 \times 10^4 \pm 7.56^a$	Absent
CoSF2	$3.75 \times 10^4 \pm 7.85^b$	Absent
CoSF3	$3.69 \times 10^4 \pm 7.32^b$	Present
CoRP1	$3.8 \times 10^4 \pm 6.92^b$	Absent
CoRP2	$6.2 \times 10^4 \pm 8.89^d$	Present
CoRP3	$5.8 \times 10^4 \pm 8.68^c$	Absent

Values are presented as mean ± standard deviation (n=6). Values within the same column followed by different superscripts are significantly different, at $p < 0.05$.

4. Conclusion

This study provides an integrated physicochemical and microbiological profile of widely consumed spices from key Bangladeshi districts, linking quality indicators (capsaicin/SHU, ASTA color, curcumin) with basic composition and safety. The observed variability—together with the detection of *Salmonella* in one coriander sample—underscores the need for stricter hygiene, moisture control, and post-harvest practices to protect consumers. The data also identify varietal and regional combinations with superior pungency and color, offering a pathway to strengthen export competitiveness through targeted cultivation and quality standards aligned with international benchmarks. We recommend producer training, routine surveillance (TPC/*Salmonella*), and adoption of Good Agricultural/Manufacturing Practices and HACCP. Future work should expand seasonal and longitudinal sampling, include mycotoxin screening, and assess supply-chain interventions to sustain quality gains.

Acknowledgment

This work was supported by SUST Research Centre, the Shahjalal University of Science and Technology and Universitas Brawijaya.

Author Contributions

A.J. and Md. M.H. formal analysis, writing original draft preparation; W.Z., E.S.M., and N.H. conceptualization, methodology, writing review and editing.

Conflicts of Interest

The author claimed no conflict of interest.

Funding

Not applicable.

Institutional Review Board Statement

Not applicable.

Data Availability Statement

Data will be made available on request to the corresponding author.

Conflicts of Interest

No conflict of interest.

References

1. Hajimonfarednejad M, Ostovar M, Raee MJ, Hashempur MH, Mayer JG, Heydari M. Cinnamon: A systematic review of adverse events. Clin Nutr [Internet]. 2019 Apr 1;38(2):594–602. Available from: https://doi.org/10.1016/j.clnu.2018.03.013
2. Akter S, Khatun R, Ahasan MM, Abedin MJ, Uddin MF, Monika AN. Analysis of spices available in local market in Bangladesh using ion beam analysis technique. IOSR J Environ Sci Toxicol Food Technol. 2016;10(09):44–7.
3. El-Sayed SM, Youssef AM. Potential application of herbs and spices and their effects in functional dairy products. Heliyon [Internet]. 2019 Jun 1;5(6). Available from: https://doi.org/10.1016/j.heliyon.2019.e01989
4. Meng Q, Ma H, Tian N, Wang Z, Cai L, Zhang Y, et al. Lp(a) and high-sensitivity C-reactive protein are predictive biomarkers for coronary heart disease in Chinese patients with type 2 diabetes mellitus. Heliyon [Internet]. 2024 Nov 15;10(21). Available from: https://doi.org/10.1016/j.heliyon.2024.e40074
5. Muzzafar MA, Ali SW, Iqbal M, Saeed M, Ahmad M, Tariq MR, et al. Comparative evaluation of ethylene oxide, electron beam and gamma irradiation treatments on commonly cultivated red chilli cultivars (Kunri and Hybrid) of Sindh, Pakistan. Heliyon [Internet]. 2024 Jan 15;10(1). Available from: https://doi.org/10.1016/j.heliyon.2023.e23476
6. BBS. Statistical Year Book Bangladesh 2016, 36th Edition [Internet]. 2017. Available from: www.bbs.gov.bd
7. Sampun CA. Red chili pepper (Capsicum annuum L.) quality after washing with chlorine disinfectant under different storage conditions: room temperature, refrigerator, and Zero Energy Cooling Chamber (ZECC). Respobio J Postharvest Technol Food Biotechnol. 2025;1(28):42–58.
8. PW B, JB B. 'Bhut Jolokia'—The world's hottest known chile pepper is a putative naturally occurring interspecific hybrid. HortScience. 2007;42(2):222–4.
9. Jalgaonkar K, Mahawar MK, Girijal S, HP G. Post-harvest profile, processing and value addition of dried red chillies (Capsicum annum L.). J Food Sci Technol [Internet]. 2024;61(2):201–19. Available from: https://doi.org/10.1007/s13197-022-05656-1
10. Moulick SP, Bashera M Al, Jahan F, Uddin MN, Rana GMM, Islam MB, et al. Turmeric (Curcuma longa L.) extract in different solvents: A comparative study of curcuminoid content, volatile compounds, and antimicrobial activity with molecular docking

insights. Food Chem Adv [Internet]. 2025;8:101074. Available from: https://www.sciencedirect.com/science/article/pii/S2772753X25001893
11. Afrin N, Jolly SN, Shilpi RY. Bacteriological study of some common dried spices and nuts of Bangladesh. Bangladesh J Bot. 2019;48(3):595–601.
12. Parveen S, Das S, Begum A, Sultana N, Hoque MM, Ahmad I. Microbiological quality assessment of three selected spices in Bangladesh. Int Food Res J. 2014;21(4):1327.
13. Hossain MA, Talukder S, Uz Zaman A, Sarkar A, Yasin M, Biswas R. Effective drying processes for Taikor (Garcinia pedunculata Roxb.) fruit by ultrasound-assisted osmotic pretreatment: Analysis of quality and kinetic models. Ultrason Sonochem [Internet]. 2024;103:106784. Available from: https://www.sciencedirect.com/science/article/pii/S1350417724000324
14. Hossain MM, Ara R, Yasmin F, Suchi M, Zzaman W. Microwave and ultrasound assisted extraction techniques with citric acid of pectin from Pomelo (Citrus maxima) peel. Meas Food [Internet]. 2024;13:100135. Available from: https://www.sciencedirect.com/science/article/pii/S2772275924000029
15. AOAC. Official Methods of Analysis, 20th ed. AOAC International; 2016.
16. de Almeida LC, Salvador MR, Pinheiro-Sant'Ana HM, Della Lucia CM, Teixeira RDBL, Cardoso L de M. Proximate composition and characterization of the vitamins and minerals of dandelion (Taraxacum officinale) from the Middle Doce River region – Minas Gerais, Brazil. Heliyon [Internet]. 2022 Dec 1;8(12). Available from: https://doi.org/10.1016/j.heliyon.2022.e11949
17. Palma-Orozco G, Orozco-Álvarez C, Chávez-Villeda AA, Mixtega-Martínez A, Castro-Muñoz R. Capsaicin content in red habanero chilli (Capsicum chinense Jacq.) and its preservation after drying process. Futur Foods [Internet]. 2021;4:100070. Available from: https://www.sciencedirect.com/science/article/pii/S2666833521000605
18. Zzaman W, Biswas R, Hossain MA. Application of immersion pre-treatments and drying temperatures to improve the comprehensive quality of pineapple (Ananas comosus) slices. Heliyon [Internet]. 2021;7(1):e05882. Available from: https://www.sciencedirect.com/science/article/pii/S2405844020327249
19. Britto GCS, Bécker G, Soares WP, Rodrigues EC, Nascimento E, Oliveira AP, et al. Physico-chemical, microbiological, and microscopic characteristics of industrialised turmeric powder. Int Food Res J. 2020;27(3):417–26.
20. Lahari R, Khokhar D, Lakra A, Pisalkar PS, Patel S, Mishra NK. Studies on physico-chemical properties of turmeric powder. J Pharmacogn Phytochem [Internet]. 2020;9(4):584–6. Available from: www.phytojournal.com
21. Mane, R.P, Kshirsagar, R.B, Sawate, A.R, Patil, B, M. and Kale, R G. Studies on evaluation of physicochemical and nutritional properties of fresh turmeric rhizome. J Pharmacogn Phytochem [Internet]. 2018;7(2):2895–7. Available from: http://www.phytojournal.com/archives/2018/vol7issue2/PartAO/7-2-356-704.pdf
22. Sharma J. Estimation of Proximate Composition of Selected Species of Capsicum (Capsicum annuum and Capsicum chinense) Grown in India. Int J Pure Appl Biosci. 2017;5(3):369–72.
23. Al Mamun A. Quality Assessment of Selected Commercial Brand of Chilli Powder in Banglades. MOJ Food Process Technol. 2016;3(2):291–4.
24. Shahwar MK, El-Ghorab AH, Anjum FM, Butt MS, Shahzad Hussain SH, Muhammad Nadeem MN. Characterization of coriander (Coriandrum sativum L.) seeds and leaves:

volatile and non volatile extracts. Int J Food Prop. 2012;15(4 PP-Philadelphia):736–747.
25. Kaur G, Kaur P, Kaur A. Physico-chemical properties, bioactive compounds and color parameters of coriander puree: effect of pretreatments and freezing. J Food Sci Technol [Internet]. 2018;55(9):3473–84. Available from: https://doi.org/10.1007/s13197-018-3272-1
26. Hussain J, Khan AL, Rehman N ur, Zainullah, Khan F, Hussain ST, et al. Proximate and Nutrient Investigations of Selected Medicinal Plants Species of Pakistan. Pakistan J Nutr. 2009;8(5):620–4.
27. Ramteke R, Gendley M, Dubey M, Dutta G, Doneria R. Chemical composition of locally available coriander (Coriander sativum) seed powder in Chhattisgarh used as feed supplements in poultry. Pharma Innov. 2022;11(3):692–4.
28. Peter K V. Handbook of herbs and spices. Vol. 2. England: Woodhead Publishing Ltd.; 2004. 158 – 174 p.
29. Popelka P, Jevinová P, Šmejkal K, Roba P. Determination of Capsaicin Content and Pungency Level of Different Fresh and Dried Chilli Peppers. Folia Vet [Internet]. 2017;61(2):11–6. Available from: https://doi.org/10.1515/fv-2017-0012
30. Baruah S, Zaman MK, Rajbongshi P, Das S. A review in recent researches in Bhut jolokia and pharmacological activity of capsaicin. Vol. 24, International Journal of Pharmaceutical Sciences Review and Research. 2014. p. 89–94.
31. M S, Gaur R, Sharma V, Chhapekar SS, Das J, Kumar A, et al. Comparative Analysis of Fruit Metabolites and Pungency Candidate Genes Expression between Bhut Jolokia and Other Capsicum Species. PLoS One [Internet]. 2016 Dec 9;11(12):e0167791. Available from: https://doi.org/10.1371/journal.pone.0167791
32. Gnayfeed MH, Daood HG, Biacs PA, Alcaraz CF. Content of bioactive compounds in pungent spice red pepper (paprika) as affected by ripening and genotype. J Sci Food Agric [Internet]. 2001 Dec 1;81(15):1580–5. Available from: https://doi.org/10.1002/jsfa.982
33. Ye Z, Shang Z, Li M, Zhang X, Ren H, Hu X, et al. Effect of ripening and variety on the physiochemical quality and flavor of fermented Chinese chili pepper (Paojiao). Food Chem [Internet]. 2022;368:130797. Available from: https://www.sciencedirect.com/science/article/pii/S0308814621018033
34. Mohan Paramkusam. Biotech Articles. 2017. Indian red chilli standards for export.
35. Niranjan A, Singh S, Dhiman M, Tewari SK. Biochemical Composition of Curcuma longa L. Accessions. Anal Lett [Internet]. 2013 May 3;46(7):1069–83. Available from: https://doi.org/10.1080/00032719.2012.751541
36. Esmaeili S, Berengi-Ardestani S, Khanniri E, Barzegar M, Sahari MA. Effect of storage time on the microbial and physicochemical properties of gamma irradiated turmeric powder under various atmospheres of packaging. Radiat Phys Chem [Internet]. 2021;187:109580. Available from: https://www.sciencedirect.com/science/article/pii/S0969806X21002309