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Compositional changes in corn cob and sheath across developmental stages: Implications for industrial use

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Abstract

This study investigated the physical, chemical, and functional characteristics of corn cob and corn sheath across six developmental stages—from silking to physiological maturity. Physical measurements showed that corn cob weight increased from 35.04 ± 0.41 g to 78.41 ± 0.16 g, while sheath weight ranged between 51.43 ± 0.28 g and 56.46 ± 0.21 g. Moisture content declined significantly in both cob and sheath with maturity, from over 91% at early stages to around 12% at maturity. Concurrently, ash, protein, fiber, carbohydrates, and structural components (cellulose, hemicellulose, and lignin) increased. Antioxidant activity and total phenols were higher at earlier stages and declined as maturity advanced. FT-IR analysis confirmed the presence of functional groups associated with carbohydrates, proteins, phenolics, and aromatic compounds in both cob and sheath. These findings demonstrate that corn processing by-products possess valuable nutritional and structural components, making them suitable for use in food, packaging, and bio-based material industries. The study promotes efficient utilization of agricultural residues for value addition and waste minimization.

Keywords: Corn cob, corn sheath, growth stages, proximate composition, FT-IR analysis, biomass utilization

1. Introduction

Corn cobs, the central part of maize (*Zea mays*), are often discarded or incinerated—practices with limited value and potential environmental harm. In a typical cornfield, dry corncobs account for approximately 1,500 pounds per acre, representing around 20% of the total corn residue, which includes both cobs and stover (Chong *et al.*, 2021) ^[21]. While corncobs have traditionally been used as animal feed (Wachirapakorn *et al.*, 2016) ^[23], they also serve as a feedstock for various energy applications, including fuel ethanol, biodiesel (Kahr *et al.* 2015) ^[14], pyrolysis bio-oil and gasification-based power generation (Biagini *et al.* 2014) ^[6]. Depending on maturity, cobs are also used in food: immature cobs are boiled and eaten whole or their kernels consumed as vegetables or canned; mature cobs are typically roasted. Additionally, corncobs are burned for fuel, used to smoke pork, or processed into charcoal. In terms of value-added product development, corncobs' high cellulose content makes them a viable carbohydrate source for producing chemical building blocks, enzymes and surfactants. Notably, the holocellulose in corncobs contains α -, β -, and γ -cellulose in the proportion of 5.2:2.8:3.0 (on an oven-dry basis). Corncobs are also rich in bioactive compounds beneficial to human health, including anthocyanins, ferulic acid, rutin, quercetin, naringenin, and kaempferol. These compounds possess antioxidant properties and promote the activity of endogenous antioxidant enzymes. Moreover, corncobs are a valuable source of dietary fiber.

In parallel, corn sheath, the outer leafy layers enveloping the cob, constitutes a major portion of post-harvest maize biomass but remains significantly underutilized (Alagbe *et al.* 2019) ^[2]. Despite being readily available alongside the cob, corn sheath is often overlooked, yet it contains appreciable levels of structural polysaccharides like cellulose, hemicellulose, and lignin—components that could be exploited for fiber recovery, bio-composite development, and biodegradable packaging materials (Hatfield and Marita, 2017) ^[12]. Additionally, like the cob, the sheath's compositional profile changes with maturity, influencing its suitability for various

industrial applications (Dong *et al.* 2019)^[11]. Its fibrous matrix and moderate nutritional content suggest potential uses in paper pulp production, composting, biopolymer extraction, and thermal insulation materials. Recent studies have indicated that the sheath contains secondary metabolites and phenolic compounds that may contribute to antioxidant activity and bio-based functionality, adding to its value in functional material development (Zhang *et al.* 2021)^[24].

As maize plants progress through different phenological stages from silking to physiological maturity the biochemical and structural composition of both the cob and sheath undergo dynamic changes (Alagbe *et al.* 2019; Dong *et al.* 2019)^[2, 11]. Moisture content, fiber fractions, protein levels, and antioxidant activity shift significantly over time, directly impacting their potential for end-use processing (Zou *et al.* 2021)^[25]. For instance, the early stages may be more suitable for nutritional applications due to higher bioactive content, whereas later stages with higher lignocellulosic content favour biofuel, packaging, and structural material development (Luo *et al.* 2017)^[15]. Understanding these changes is critical for optimizing harvest timing, improving processing efficiency, and promoting the circular economy in agriculture.

Good planting date is one of the crucial factors that strongly influence crop production in rainfed agriculture. The bioconversion of lignocelluloses to biofuel from cheap non-edible materials such as corn cob for renewable energy is imperative. Thus, by varying temperature conditions during the fermentation process, maximum productivity of biofuel on an industrial scale can be optimized. In the brewing industry, production of biofuel is carried out by the fermentation of starchy materials, in which case, sugars are converted into bioethanol with carbon dioxide and water (Castrillón *et al.* 2021)^[8] as byproducts. Therefore, it is an exciting research area to use both corn cob and corn sheath for chemical and biochemical processing to obtain end products with added values. Enhancing the value of these agricultural residues not only reduces environmental impact but also supports rural bioeconomy, resource efficiency, and sustainable development goals.

2. Material methods

Sample Preparation

Plant Material

The raw materials—corn cobs and corn sheaths (leaves)—were collected from local farms in the Nauni region of Solan, Himachal Pradesh (30°51'45"N 77°10'04"E/30.8625118°N 77.1679151°E) during the months of August to October in the years 2023 and 2024. Corn, sown in April, June, and August to determine the most suitable varieties and optimal planting times for achieving higher yields and improved nutritional quality under varying climatic conditions. Corn cultivation involves three key developmental stages that generate the most agricultural waste: the milking stage, which occurs about 22 days after silking when kernels contain a milky fluid; the dough stage, when the kernel fluid thickens to a dough-like consistency; and the physiological maturity stage, when the kernels are fully developed and dry. During the milking and dough stages, corn cobs with kernels are often sold roasted by roadside vendors, leaving behind the sheaths as waste. At physiological maturity, the crop is harvested, and kernels are separated from the cobs for drying and further processing, while the remaining cobs are typically discarded in the fields. These corn residues—sheaths and cobs—transported to the Department of Food Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry (UHF), Nauni, Solan

(H.P), for further experimentation as part of the research objectives

Quality parameters

The carefully sorted the corn sheaths and cobs, washed with potable water, and dried using a mechanical dehydrator (Widson Scientific Works, Delhi) at 60±2 °C until they reached a moisture content of 8-10%. The dried corn sheaths, containing 8.51% moisture, were ground into a fine powder using a mixer grinder (Suvidha Mixer). The resulting material was passed through a stainless-steel sieve with a mesh size of 60, corresponding to a particle size of 250 µm.

Corn cobs, manually chopped into 5 cm thick pieces to increase the surface area for effective drying. Once dried to a moisture content of 8.54%, they were ground into powder using a WILLEY WM-500 grinder. The powder then sieved through a 60-mesh screen to achieve a uniform particle size of 250 µm. Finally, the powdered materials packed in LDPE pouches and stored at ambient temperature for further analysis.

Physical parameters

To determine the weight distribution of different parts of the corn ear, ten randomly selected whole corn ears weighed using an electronic weighing balance. The percentage composition of corn kernels, cob, sheath, and stalk calculated using the formula:

Part percentage (%) = $\frac{\text{[(Total weight of whole corn ear - Weight of each part)]}}{\text{Total weight of whole corn ear}} \times 100$.

Additionally, the physical dimensions of the corn cobs are measured to assess their size characteristics. For this, the length (L) and diameter (D) of ten randomly chosen corn cobs were measured using a digital vernier caliper by placing each cob between the caliper jaws to obtain direct readings.

Chemical parameters

The moisture content of the samples measured by drying a known weight of each sample in a hot air oven set at 70±2 °C until a constant weight achieved, following the protocol described by Ranganna (2009)^[18]. For ash content analysis, samples incinerated in a muffle furnace at 550±2 °C for 3 to 4 hours until a white, carbon-free ash obtained, as per Ranganna's method. Fat content was quantified using an automated Soxhlet fat extraction system (Model: Sox2 version 0.1), according to the procedure outlined in AOAC (2012)^[26]. Crude fibre, determined using the FibroTRON-FRB-2 fiber analyzer, also based on AOAC (2012)^[26] guidelines. Total carbohydrate content was estimated using the difference method outlined by Ranganna (2009)^[18], which involves subtracting the sum of moisture, protein, fat, ash, and fiber percentages from 100. Protein content, assessed via the Kjeldahl digestion method using an integrated digestion and scrubber unit from Buchi Pvt. Ltd., with minor adjustments as per Ranganna (2009)^[18]. Nitrogen percentage converted to protein using the conventional factor of 6.25. Crude fiber and fat analysis were also conducted using a Fiber Analyzer and a Soxhlet oil extractor (M/s Velp Scientifica, SRL, Italy), respectively, pre-set at 130±2 °C with a 60-minute washing cycle and 15-minute solvent recovery phase, based on Ranganna's methods. Carbohydrate levels further validated using the phenol-sulphuric acid assay with glucose as the calibration standard (Ranganna, 2009)^[18]. The total phenolic content and antioxidant activity measured following the Bray and Thorpe (1954)^[7] methodology. For antioxidant testing, methanol used as a blank, and absorbance monitored at 515 nm using a UV-VIS spectrophotometer until it stabilized. Residual DPPH concentration then calculated to determine antioxidant

capacity. Colour characteristics of the samples were assessed using a Lovibond Colour Tintometer (Model PFX-I series spectro colorimeter), which provided both RYBN and CIE *Lab** colour values. Here, the *L** value denotes brightness (ranging from 0 for black to 100 for white), the *a** value reflects the green-to-red spectrum, and the *b** value represents the blue-to-yellow spectrum (Ranganna, 2009) [18].

Energy value (kcal/100g)

The calorific value of the sample determined using a bomb calorimeter (Model: Toshiwal DT-100), which operates on the principle that the heat released from the combustion of a sample is equal to the heat absorbed by the calorimeter system. To begin, the crushed the sample and dried in a hot air oven to eliminate moisture and form a solid mass suitable for combustion. One gram of the dried sample used for the analysis. The calorimeter chamber filled with 1500 mL of distilled water, and the sample placed in the combustion crucible. An ignition wire attached to the central terminal on the bomb head, while a second wire connected to the designated socket on the bomb hanger. A cotton thread, connected to the ignition wire, inserted into the sample to aid ignition. The chamber then purged with pure oxygen to facilitate combustion. As the temperature increased, the sample ignited and burned completely. The resulting energy release was measured, and the calorific value was displayed by the instrument in kcal per 100 grams of the sample (Shehab *et al.* 2022) [21].

Hemicellulose Content (%)

Hemicellulose content, estimated following the procedure outlined by AOAC (1970) [4]. For the analysis of acid detergent fiber (ADF), one gram of dried and ground sample was treated with 100 mL of ADF solution, prepared by dissolving 20 g of cetyltrimethylammonium bromide (CTAB) per liter of 1 N sulfuric acid. The mixture refluxed for one hour on a hot plate. Following digestion, the contents filtered through a pre-weighed sintered glass crucible. The retained residue sequentially washed with distilled water and acetone, dried at 80 °C for 24 hours, and weighed to determine the ADF content. To assess neutral detergent fiber (NDF), one gram of powdered sample was combined with 100 mL of NDF solution composed of 30 g sodium lauryl sulfate, 18.61 g EDTA, 6.81 g sodium borate decahydrate, and 4.56 g disodium hydrogen phosphate dissolved in 1 liter of distilled water. Subsequently, 10 mL of 2-ethoxyethanol was added to the solution, which was vigorously agitated to ensure proper dissolution. The pH of the solution adjusted to 7.0. The sample mixture then refluxed for one hour on a hot plate. After treatment, the contents filtered, washed thoroughly with boiling water until the foam disappeared, followed by a final rinse with acetone. The residue dried overnight at 80±2 °C and weighed to calculate NDF content.

Hemicellulose (%) = NDF-ADF

Lignin Content (%)

Lignin content in corn cob and sheath samples, determined using the procedure outlined by AOAC (1970) [4]. One gram of the ground sample treated with 10 mL of 72% (v/v) sulfuric acid and incubated at ambient temperature (30±2 °C) for three hours. The mixture stirred once every hour during incubation to ensure thorough digestion. After incubation, the mixture filtered, and the residue washed thoroughly with hot water to eliminate residual acid. The washed residue then dried in a hot air oven at 100±2 °C for one hour. Subsequently, the dried sample placed in

a muffle furnace and ignited at 500±2 °C for one hour. After cooling, the residue weighed. The lignin content calculated based on the weight loss observed after ignition at 500±2 °C.

Cellulose content (%)

Cellulose content in the fiber quantified by calculating the proportion of cellulose extracted relative to the initial dry weight of the sample. The extraction yield expressed as grams of cellulose obtained per 100 grams of fiber material. The overall yield was determined using the following formula:

$$\text{Yield (\%)} = \frac{\text{Weight of extract cellulose (g)}}{\text{Weight of fibre (g)}} \times 100$$

Fourier transforms infrared (FTIR) spectrophotometric analysis

For qualitative characterization, Fourier Transform Infrared (FTIR) spectroscopy was performed on corn cob samples using a Shimadzu 8400 S FTIR spectrometer equipped with a KBr beam splitter. Approximately 5 mg of each sample finely mixed with 5 mg of potassium bromide (KBr) and pressed into a pellet. Spectral data collected in the range of 4000 to 400 cm⁻¹, with a resolution of -0.85 cm⁻¹. The resulting spectra analyzed and interpreted in accordance with the guidelines provided by Tkachenko and Niedzielski (2022) [22].

Statistical analysis

All experimental data subjected to statistical analysis to ensure accuracy and reliability. The results expressed as mean values along with their corresponding standard errors (Mean ± SE). Statistical evaluation performed using appropriate tools to determine the variability and significance of the observed parameters. This approach allowed for accurate interpretation of the data and ensured consistency in the reported findings.

3. Result and Discussion

Physical characteristics

Parts of corn ear

Table 1 presents the percentage composition of various parts of the corn ear at different growth stages (Figure 1). During the silking and blister stages, the proportions of silk, cob, and sheath were recorded as 13.77±0.44% and 8.10±0.10%; 34.60±0.26% and 40.92±0.17%; and 49.17±0.05% and 36.09±0.41%, respectively. At the milking and dough stages, the percentages of silk, cob, sheath, and kernels were found to be 3.48±0.18% and 3.44±0.18%; 50.31±0.30% and 38.30±0.23%; 42.74±0.27% and 20.61±0.25%; and 8.58±0.21% and 32.98±0.13%, respectively. In the dent stage, the respective percentages of silk, cob, sheath, and kernels were 3.30±0.80%, 25.96±0.46%, 19.53±0.43%, and 47.26±0.10%. At physiological maturity, the proportions were recorded as 2.37±0.22% for silk, 23.64±0.06% for cob, 16.64±0.24% for sheath, and 53.92±0.20% for kernels.

Physical characteristics of corn waste at different stages

The physical characteristics of corn cobs and sheaths across different growth stages are summarized in Table 2 and Figure 2. The average weight of corn cobs increased markedly from 35.04±0.41 g at the silking stage to 78.41±0.16 g at physiological maturity. Cob length varied between 12.70±0.24 cm and 20.39±0.15 cm, while the diameter ranged from 2.50±0.31 cm to 8.58±0.11 cm. These values align closely with those reported by Sharma (2022) [27], Ashraf *et al.* (2015) [28], and Singh *et al.* (2015) [29] for similar corn cob

characteristics. Likewise, the corn sheath exhibited relatively stable weight across developmental stages, ranging from 51.43±0.28 g to 56.46±0.21 g. Sheath length spanned 13.03±0.13 cm to 21.24±0.14 cm, while width increased from 3.32±0.07 cm to 6.51±0.16 cm during the progression from silking to full maturity. These measurements are consistent with earlier findings reported by Saleh *et al.* (2002) ^[30], Hasdiana and Ayuddin (2017) ^[31], and Neupane *et al.* (2011) ^[32] on corn sheath morphology.

Chemical Characteristics

Chemical characteristics of corn waste at different stages

The chemical composition of corn cob and corn sheath at various developmental stages is presented in Tables 3, respectively. Moisture content in the corn cob decreased progressively from 91.06±0.03% at the silking stage to 12.11±0.05% at physiological maturity, reflecting reduced perishability with maturity. Ash content, indicative of mineral content, increased from 3.07±0.02% to 4.93±0.14% across the same stages. Crude protein, total fibre, fat, and carbohydrate contents ranged from 5.30±0.11% to 5.28±0.16%, 19.31±1.19% to 42.96±0.17%, 0.57±0.01% to 0.71±0.35%, and 80.02±0.76% to 88.40±0.05%, respectively. Antioxidant activity and total phenolic content showed a decreasing trend with maturity, ranging from 53.63±0.75% to 30.44±0.34%, and 47.47±0.52 mg GAE/100g to 28.43±0.71 mg GAE/100g, respectively, while energy value increased from 274.64±0.55 to 356.47±0.06 Kcal/100g. The structural carbohydrate profile revealed increasing cellulose (15.17±0.25% to 34.36±0.07%), hemicellulose (33.81±0.29% to 42.89±0.13%), and lignin content (9.94±0.53% to 17.27±0.22%) with maturity. Similarly, in corn sheath, moisture content declined significantly from 91.56±1.11% at the silking stage to 11.39±0.22% at physiological maturity, while ash content ranged between 3.34±0.06% and 4.64±0.22%. The highest levels of crude protein (3.54±0.20%), total fibre (35.68±0.16%), fat (1.94±0.16%), and carbohydrates (88.40±0.18%) were observed during the dough stage. Antioxidant activity and total phenolic content ranged from 25.45±0.19% to 15.08±0.14%, and 19.43±0.30 mg GAE/100g to 12.38±0.17 mg GAE/100g, respectively, across developmental stages, while energy value increased to a maximum of 537.38±1.81 Kcal/100g at maturity. Cellulose, hemicellulose, and lignin content also followed an increasing trend, with peak values of 52.63±0.20%, 47.12±0.14%, and 19.44±0.23% recorded at physiological maturity, respectively. These findings are in line with previous studies by Nleya *et al.* (2016) ^[16], Bashir *et al.* (2024) ^[5] and

Samanta *et al.* (2023) ^[19].

Fourier transforms infrared (FTIR) spectrophotometric analysis

FT-IR spectra

FT-IR spectral analysis of both corn cob and corn sheath was carried out to identify the functional groups responsible for their chemical characteristics, as illustrated in Figures 3 and detailed in Tables 4. The transmittance spectra in the 4000-400 cm⁻¹ range revealed distinct and comparable functional group peaks in both materials, confirming the presence of various biochemical constituents. In the corn cob spectrum, a prominent O-H stretching band at 3248 cm⁻¹ indicated the presence of carboxylic acids, representing carbohydrates, while peaks at 2097 cm⁻¹ and 2161 cm⁻¹ corresponded to isothiocyanate (N=C=S) and azide (N=N=N) functional groups, associated with carbohydrate and protein content, respectively. Additional bands at 3367 cm⁻¹ (N-H stretching), 1380 cm⁻¹ and 784 cm⁻¹ (C-H bending), and 1037 cm⁻¹ (S=O stretching) indicated the presence of aliphatic amines, alkanes, aromatic compounds (phenols), and sulphoxide. Similarly, the FT-IR spectra of corn sheath revealed characteristic peaks signifying the presence of carbohydrates, proteins, phenols, alcohols, carboxylic acids, anhydrides, and alkanes. Major peaks were observed at 3754 cm⁻¹ and 3605 cm⁻¹ (O-H stretching), 2362 cm⁻¹ and 2407 cm⁻¹ (isocyanate and anhydride compounds), 1037 cm⁻¹ (S=O stretching), and 732 cm⁻¹ (C-H bending), consistent with the findings in the corn cob analysis. The observed functional groups in both spectra confirm the biochemical richness of corn cob and sheath, aligning with results reported by Padilla *et al.* (2024) ^[17], Amer *et al.* (2021) ^[3], Devi *et al.* (2022) ^[10], Ji *et al.* (2020) ^[13] and Abou-Hadid *et al.* (2024) ^[1]. This FT-IR evidence substantiates the nutritional and compositional potential of these corn by-products for further valorization in food, pharmaceutical, and industrial applications. Corn cob and corn sheath, often regarded as agricultural waste, possess significant nutritional and functional value, making them suitable for various value-added processing applications. Rich in fibre, carbohydrates, minerals, and bioactive compounds such as phenols and antioxidants, these by-products offer potential for utilization in the development of biodegradable packaging materials, animal feed, bio-composites, and as raw material for biofuel and fermentation industries. The high cellulose, hemicellulose, and lignin content further enhances their utility in producing paper, bioplastics, and natural fibres. Therefore, effective valorization of corn cob and sheath not only supports waste minimization but also contributes to sustainable and eco-friendly industrial practices.

Table 1: Parts of corn ear at different stages

Stages Parameters	Silking Stage	Blister Stage	Milking Stage	Dough Stage	Dent Stage	Physiological maturity Stage
Silk (%)	13.77±0.44	8.10±0.10	3.48±0.18	3.44±0.18	3.03±0.80	2.37±0.22
Cob (%)	34.60±0.26	40.92±0.17	50.31±0.30	38.30±0.23	25.96±0.46	23.64±0.06
Sheath (%)	49.17±0.05	36.09±0.41	42.74±0.27	20.61±0.25	19.53±0.43	16.64±0.24
Kernels (%)	--	--	8.58±0.21	32.98±0.13	47.26±0.10	53.92±0.20

Values are expressed as Mean ± SE (n = 10)

Table 2: Physical characteristics of corn waste at different stages

Stages	Parameters							
	Weight (g)		Length (cm)		Diameter (cm)		Visual colour*	
	Corn cob	Corn sheath	Corn cob	Corn sheath	Corn cob	Corn sheath	Corn cob	Corn sheath
Silking Stage	35.04±0.41	51.43±0.28	12.70±0.24	13.03±0.13	2.50±0.31	3.32±0.07	White group N155 (D)	Green-yellow group 149 (C)
Blister Stage	89.20±0.20	56.58±0.19	14.72±0.13	15.96±0.03	3.45±0.08	4.42±0.08	White group N155 (D)	Green-yellow group 149 (C)
Milking Stage	98.26±0.18	141.32±0.08	16.53±0.11	17.47±0.16	5.48±0.22	6.54±0.18	Yellowish White NN155 (A)	Green group 142 (A)
Dough Stage	83.87±0.25	137.12±0.18	18.71±0.13	19.29±0.21	6.52±0.20	6.52±0.20	Yellowish White NN155 (A)	Green group 145 (C)
Dent Stage	80.59±0.43	61.64±0.24	20.28±0.13	21.61±0.40	8.39±0.12	6.72±0.29	White group N155 (D)	Green group 145 (D)
Physiological maturity Stage	78.41±0.16	56.46±0.21	20.39±0.15	21.24±0.14	8.58±0.11	6.51±0.16	White group N155 (D)	Yellow-green group 150 (D)

Values are expressed as Mean ± SE (n = 10)

*As per Royal Horticulture Society Colour Chart, London

Table 3: Chemical characteristics of corn waste at different stages

Stages Parameters	Silking Stage		Blister Stage		Milking Stage		Dough Stage		Dent Stage		Physiological maturity Stage	
	Corn cob	Corn sheath	Corn cob	Corn sheath	Corn cob	Corn sheath	Corn cob	Corn sheath	Corn cob	Corn sheath	Corn cob	Corn sheath
Moisture content (%) (wet basis)	91.06±0.03	91.56±1.11	87.87±0.34	88.42±0.32	56.66±0.35	64.29±0.23	19.35±0.35	15.19±0.12	15.09±0.51	13.75±0.31	12.11±0.05	11.39±0.16
Ash content (%) **	3.07±0.02	3.34±0.06	3.43±0.11	3.74±0.16	3.97±0.07	4.50±0.18	4.25±0.39	4.53±0.28	4.63±0.12	4.77±0.12	4.93±0.14	4.64±0.22
Crude protein (%) **	5.30±0.11	2.79±0.13	5.58±0.15	2.86±0.21	5.35±0.65	3.24±0.38	5.39±0.04	3.54±0.20	5.41±0.07	3.28±0.19	5.28±0.16	3.22±0.13
Crude fibre (%) **	19.31±1.19	24.92±0.13	20.52±0.09	26.25±0.20	22.72±0.30	26.73±0.58	25.22±0.23	35.68±0.16	26.37±0.37	34.20±0.16	30.16±0.17	34.02±0.14
Total fat (%) **	0.57±0.02	1.29±0.05	0.60±0.17	1.61±0.11	0.65±0.03	1.81±0.10	0.71±0.35	1.94±0.16	0.45±0.02	1.63±0.12	0.43±0.01	1.39±0.15
Total carbohydrates (%) **	80.02±0.76	83.63±0.14	80.22±0.35	86.33±0.28	85.52±0.21	87.37±0.15	85.66±0.40	88.40±0.18	86.79±0.45	88.34±0.18	88.40±0.05	84.42±0.24
Antioxidant activity (% DPPH) **	53.63±0.75	25.45±0.19	50.30±0.44	21.66±0.18	45.16±0.15	20.48±0.20	37.22±0.05	20.21±0.21	32.80±1.49	19.41±0.10	30.44±0.34	15.08±0.14
Total phenols (mgGAE/100 g) **	47.47±0.52	19.43±0.30	43.58±0.30	18.47±0.21	39.78±0.02	16.08±0.13	35.65±0.05	14.81±0.23	29.13±0.41	14.24±0.21	28.43±0.71	12.38±0.17
Energy value (Kcal/100 g) **	274.64±0.55	324.17±0.28	301.26±0.21	389.25±2.46	332.48±0.50	461.55±3.45	364.19±0.40	569.00±3.72	388.11±0.51	540.33±4.49	356.47±0.06	537.38±1.81
Cellulose (%) **	15.17±0.25	44.34±0.98	21.42±0.16	47.40±0.35	31.34±0.24	48.31±0.34	32.43±0.34	53.57±0.19	34.27±0.42	52.60±0.16	34.36±0.07	52.63±0.20
Hemicellulose (%) **	33.81±0.29	41.43±0.28	35.82±0.33	42.54±0.30	39.51±0.36	45.24±0.33	42.65±0.04	47.33±0.17	42.87±0.50	47.09±0.17	42.89±0.13	47.12±0.14
Lignin (%) **	9.94±0.53	12.43±0.34	11.36±0.15	13.40±0.25	13.01±0.29	14.67±0.27	15.17±0.28	19.76±0.18	17.23±0.48	19.61±0.15	17.27±0.22	19.44±0.23

Values are expressed as Mean ± SE (n = 10)

** Dry basis

Table 4: FT-IR Spectra of corn waste

Corn cob		
Peak range cm ⁻¹	Group stretching	Compound
3367cm ⁻¹	N-H Stretching	Aliphatic primary amine (Protein)
3248cm ⁻¹	O-H Stretching	Carboxylic acid (Carbohydrates)
2097cm ⁻¹	N=C=S Stretching	Isothiocyanate (Carbohydrates)
2161cm ⁻¹	N=N=N Stretching	Azide (Protein)
1380cm ⁻¹	C-H Bending	Alkane (Carbon)
1037cm ⁻¹	S=O Stretching	Sulphoxide (Quinoxaline)
784cm ⁻¹	C-H bending	Aromatic compounds (Phenols)
Corn sheath		
Peak range cm ⁻¹	Group stretching	Compound
3754 cm ⁻¹	O-H	Carboxylic acid (Carbohydrates)
3605 cm ⁻¹	N-H	Amines (Protein)
2362 cm ⁻¹	N=C=O	Isocyanate (Carbohydrates)
2407 cm ⁻¹	C-H	Aromatic compound (Phenols)
1037 cm ⁻¹	CO-O-CO	Anhydride
732 cm ⁻¹	C=C	Alkanes (Carbon)



Fig 1: Parts of corn year

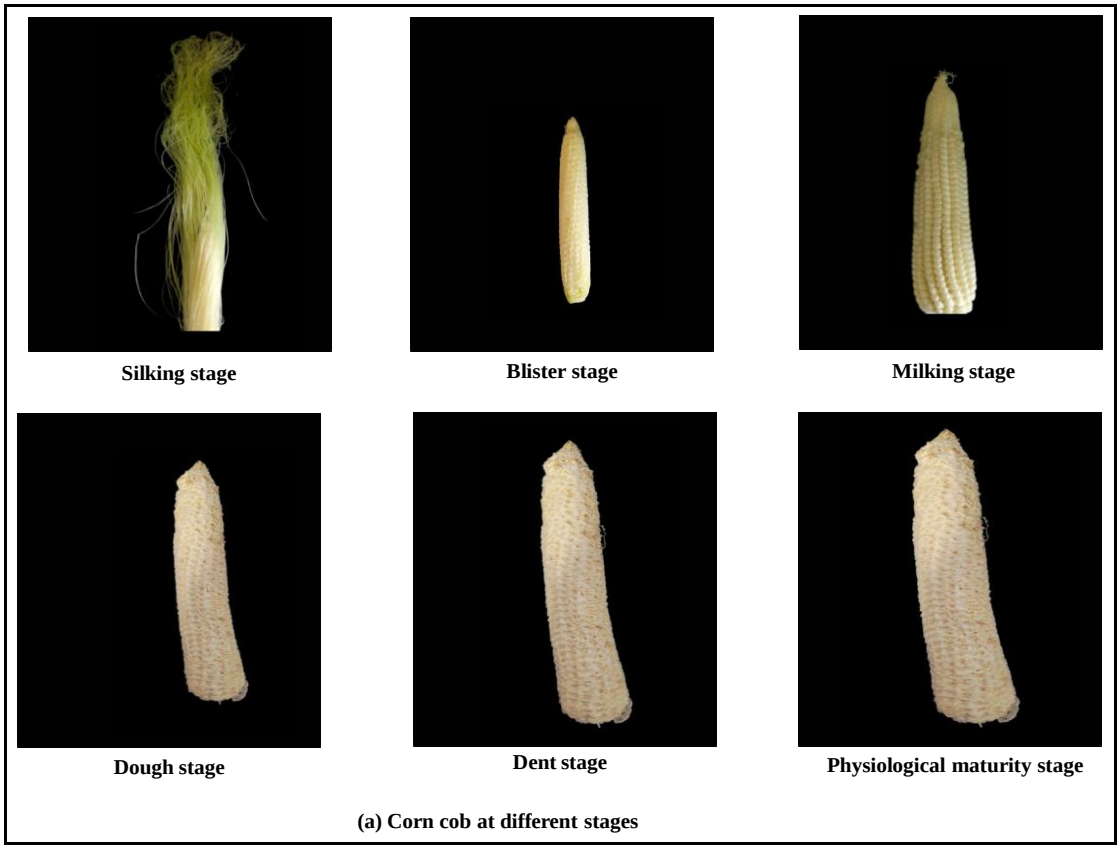
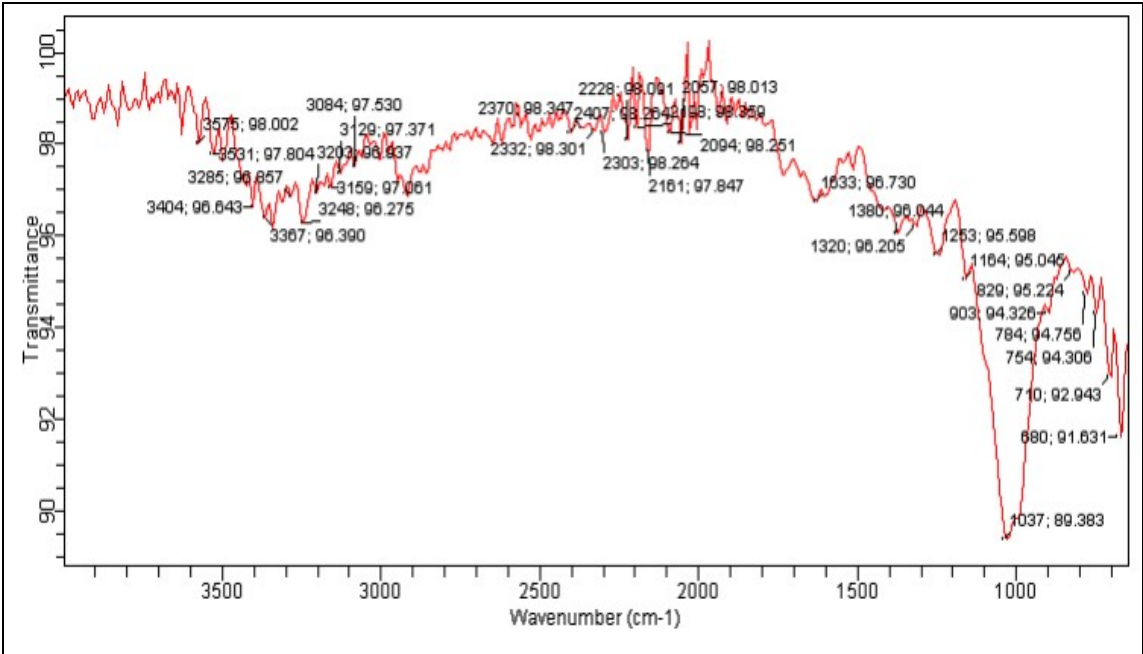
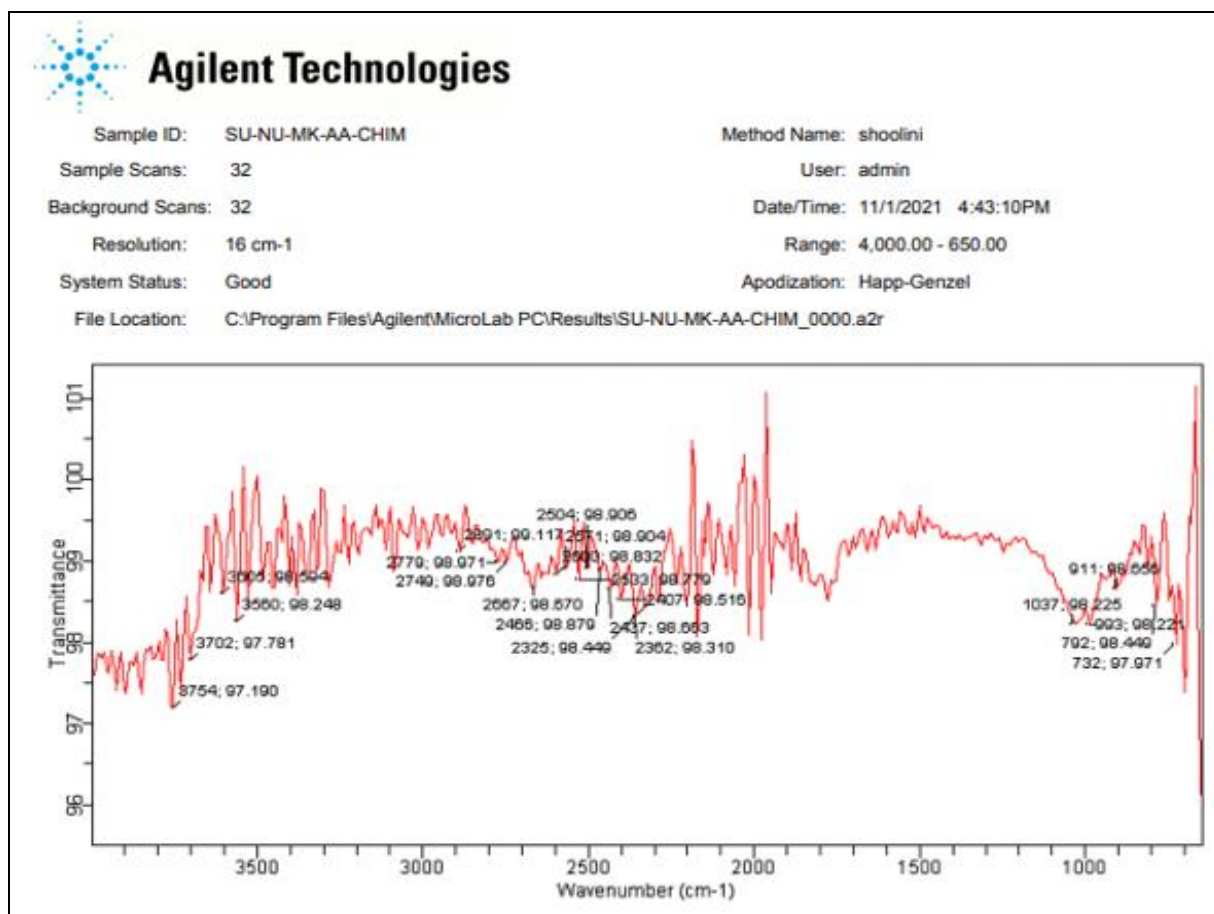




Fig 2: Pictorial representation of corn waste at different stages



(a) corn cob



(b) corn sheath

Fig 3: FTIR Spectral of corn waste

4. Conclusion

The present study comprehensively evaluated the physical and chemical characteristics of corn cob and corn sheath across different growth stages, highlighting their significant nutritional and functional potential. The analysis revealed that both corn cob and sheath contain appreciable amounts of moisture, protein, fibre, fat, carbohydrates, ash, and bioactive compounds such as phenols and antioxidants. The FT-IR spectra further confirmed the presence of key functional groups associated with carbohydrates, proteins, phenolic compounds, and other bioactive constituents, indicating their value as functional materials. The gradual changes observed in physicochemical properties from silking to physiological maturity underscore their dynamic compositional nature. These findings suggest that corn cob and corn sheath—typically considered agricultural waste—are valuable sources of nutritionally and industrially important compounds. Hence, their utilization in food processing, bio-composite materials, nutraceuticals, and value-added products presents a sustainable approach to waste valorization and circular bioeconomy.

5. Future Perspective

The findings of this study highlight the potential of corn cob and corn sheath as valuable sources of bioactive and nutritional compounds. Future research can focus on the development of value-added products such as biodegradable packaging materials, dietary fiber supplements, and natural antioxidants. Further exploration of their industrial applications in food, pharmaceutical, and biofuel sectors can promote sustainable utilization of agricultural waste and contribute to circular

bioeconomy initiatives.

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7. Conflict of Interest

The authors declare no conflict of interest.

8. Ethical Statement

This study did not involve any human participants or animals. All experimental procedures were conducted in accordance with institutional and ethical guidelines for research.

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