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Comparative analysis of nutrient composition and phytochemicals in seeds of Cucurbitaceae family with extraction of pumpkin seed oil

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Abstract
The Cucurbitaceae family includes several economically and nutritionally significant crops, yet the seeds of many species, such as Cucurbita maxima (pumpkin) and *Citrullus lanatus* (watermelon), remain underutilized despite their rich bioactive and nutritional potential. This study presents a comparative analysis of the proximate nutrient composition and phytochemical constituents of pumpkin and watermelon seeds, with additional evaluation of pumpkin seed oil extraction using the Soxhlet method. Seeds were collected from local markets in Gurugram, India, processed, and analyzed using standard AOAC protocols. Watermelon seeds were found to contain higher levels of protein (30%) and fat (51.5%), while pumpkin seeds exhibited superior ash content (7%), indicating higher mineral density. Qualitative phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, phenols, terpenoids, and saponins in both seeds, with pumpkin seeds showing greater diversity and intensity. Soxhlet extraction yielded 46% oil from pumpkin seeds, which was rich in unsaturated fatty acids, sterols, and antioxidants, making it suitable for dietary, cosmetic, and pharmaceutical applications. This study not only highlights the nutritional and medicinal significance of these often-discarded seeds but also supports their use in sustainable food systems and functional product development. The findings contribute new insights into the biochemical value of Cucurbitaceae seeds and promote their role in enhancing nutritional security, reducing food waste, and encouraging plant-based alternatives in oil and health.

Keywords: Cucurbitaceae, cucurbita maxima, *Citrullus lanatus*, nutritional analysis, phytochemicals, soxhlet extraction, seed oil

Introductions
The Cucurbitaceae family includes 125 genera and 825 Species. This family consists of different varieties of plants known for their medicinal properties. These plants typically grow in tropical and subtropical climates. They exhibit diverse Reproductive forms, being monoecious, dioecious, or sometimes hermaphroditic. A key Anatomical trait of this family is the presence of bicollateral vascular bundles, where Phloem tissues are found on both sides of the xylem. Many cucurbits also produce a Compound called cucurbitacin, which imparts a bitter taste and contributes to their biological Activity Samanta *et al*., (2024) [18].
This study focuses on the seeds of Cucurbita maxima (pumpkin) and *Citrullus lanatus* (watermelon), evaluating their nutritional composition protein, fat, fibre, carbohydrates, ash, and moisture and their phytochemical constituents.
Pumpkin seeds are rich in minerals such as zinc, phosphorus, magnesium, potassium, and selenium, which help combat arthritis, inflammation, and prostate disorders (Maheshwari *et al*., 2015) [2]. They also contain beneficial lipids, linoleic and oleic acids, and are high in proteins, fibre, and antioxidants (N Manda Devi *et al*., 2018) [3]. Watermelon seeds, likewise, are a nutritious source of protein, vitamin B, minerals, healthy fats, and phytochemicals (Braide *et al*., 2012) [4]. However, limited studies have explored how watermelon seed variety influences nutritional value (Manjulika *et al*., 2004) [5].
Phytochemical screening of pumpkin and watermelon seeds reveals compounds like alkaloids, phenols, flavonoids, terpenoids, and saponins. Notably, pumpkin seeds contain cucurbitacin E and tocopherols, known for anti-inflammatory and antioxidant effects (Sarah Jane Monica *et al*., 2022) [6].

The family as a whole Is known for diverse reproductive forms (monoecious/dioecious), and unique anatomical features like bicollateral vascular bundles. As noted by Austin Deyo *et al*. (2008) [9], the family is divided into Zanonioideae and Cucurbitoideae sub-families. Besides nutritional benefits, research also highlights the oil-yielding potential of cucurbit seeds, meeting rising demands for plant-based oils (Ingle A* *et al*., 2022) [7].

Materials and Methods

Collection and Preparation of Seeds

The seeds of Cucurbita maxima (pumpkin) and *Citrullus lanatus* (watermelon) were collected from local markets in Gurugram, Haryana. The collected seeds were washed thoroughly with water to remove any dirt and then dried in an oven at 60 °C. Once dried, the seeds were manually dehulled, and the kernels were ground into a fine powder using a mechanical grinder. This powdered form was used for all subsequent nutritional and phytochemical analysis.

Proximate Nutritional Analysis

Proximate nutritional analysis was carried out on seed powders of Cucurbita maxima (pumpkin) and *Citrullus lanatus* (watermelon) to estimate their moisture, ash, protein, fat, fibre, and carbohydrate content using standard AOAC (1990) [21] methods.

Moisture Content

Moisture content was determined using the gravimetric method. Two grams of each powdered sample were placed in a pre-weighed crucible and dried in a hot air oven at 105 °C until a constant weight was achieved. The moisture content was then calculated by subtracting the final dry weight from the initial sample weight (AOAC, 2006) [8].

Formula Used: Moisture (%) = [(Initial weight − Dry weight)/Initial weight] × 100

Ash Content

Ash content was measured to determine the total mineral matter. Two grams of dried sample were incinerated in a muffle furnace at 550 °C for 4-6 hours until white ash was formed. The residue was cooled in a desiccator and weighed (Schofield *et al*., 2001) [9].

Formula Used: Ash (%) = (Weight of ash/Weight of sample) × 100

Crude Fibre

Crude fibre content was estimated through acid-alkali digestion. The defatted sample (2 g) was treated with 1.25% sulfuric acid followed by 1.25% sodium hydroxide. The residue was filtered, dried, and then ash in a muffle furnace. Fibre was calculated by subtracting the ash weight from the residue weight after digestion (Schofield *et al*., 2001) [9].

Formula Used: Crude Fibre (%) = [(Weight of residue − Ash)/Weight of sample] × 100

Fat Content

Fat content was determined using Soxhlet extraction. Two grams of each powdered seed sample were packed in a thimble and extracted with chloroform as the solvent for 6 hours. After extraction, the solvent was evaporated, and the remaining oil was weighed (Syam, A. *et al*., 2023) [10].

Formula Used: Fat (%) = (Weight of extracted oil/Weight of sample) × 100

Protein Content

Protein content was estimated using Lowry's method. Seed extracts were treated with Folin-Ciocalteu reagent after reaction with alkaline copper sulfate. The blue color developed was measured spectrophotometrically at 660 nm using Bovine Serum Albumin (BSA) as the standard Lowry OH *et al*., 1951) [11].

Carbohydrate Content

Carbohydrates were calculated by the difference method, which subtracts the sum of moisture, ash, protein, fat, and fibre percentages from 100 (Zehara Seid Yimer *et al*., 2020) [12].

Formula Used: Carbohydrate (%) = 100 − (Protein + Fat + Ash + Fibre + Moisture).

Qualitative Phytochemical Analysis

Qualitative phytochemical screening of seed extracts of Cucurbita maxima and *Citrullus lanatus* was performed using standard methods to detect the presence of major bioactive compounds.

Alkaloids were tested using Wagner's reagent, where the formation of a reddish-brown precipitate indicated a positive result (Mamta S *et al*., 2012) [13].

Flavonoids were confirmed using the alkaline reagent test and lead acetate test, which produced a yellow color (Khan MR *et al*., 2013) [14].

Tannins were detected by adding ferric chloride, which gave a greenish-black color (Doherty VF *et al*., 2010) [15].

Phenols were identified using the Folin-Ciocalteu reagent, which produced a blue-green color (Lalrinzuali K *et al*., 2015) [16].

Terpenoids were tested using the Salkowski test, which formed a reddish-brown layer at the interface (G.E. Irabor *et al*., 2020) [17].

Saponins were identified by the foam test, where persistent frothing indicated a positive result (Baba SA *et al*., 2015) [19].

Extraction of Pumpkin Seed Oil

Pumpkin seeds (Cucurbita maxima) were collected from a local market in Gurugram, Haryana. The seeds were washed, oven-dried at 60 °C, dehulled, and ground into fine powder. Oil extraction was performed using the Soxhlet method, where 2 g of seed powder was extracted with chloroform for 6 hours. After extraction, the solvent was evaporated using a water bath, and the reddish-green oil was collected.

The oil yield was calculated using the formula:

Oil yield (%) = (Weight of extracted oil/Weight of sample) × 100

Results and Discussion

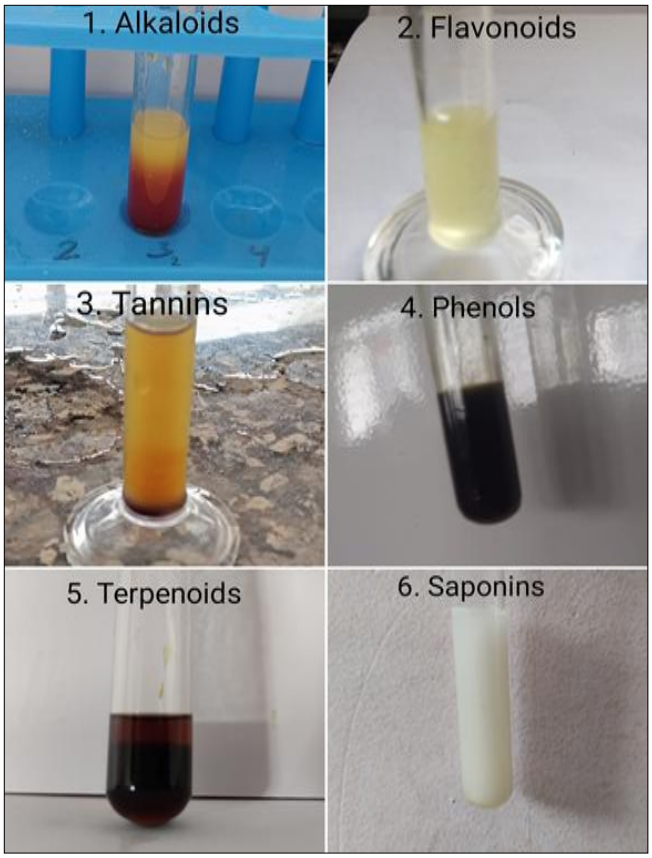
The proximate composition analysis revealed significant nutritional differences between *Cucurbita maxima* and *Citrullus lanatus* seeds.

Table 1: Nutritional composition of cucurbit seeds:

Components	Pumpkin seeds	Watermelon seeds
Moisture content (per 5 g)	7%	3%
Ash content (per 5 g)	6%	3%
Fibre content (per 2 g)	1.61%	5.10%
Fat content (per 2 g)	46%	51.5%
Protein content (per 2 g)	30%	20.64%
Carbohydrates content	9.4%	10.4%

Table 2: Qualitative phytochemical analysis:

Phytochemicals	Pumpkin seeds	Watermelon seeds
Alkaloids	(++)	(++)
Flavonoids	(++)	(++)
Tannins	(+)	(++)
Phenols	Slightly Present	(+)
Saponins	(+)	(++)
Terpenoids	(++)	(+)



3.3. Oil Yield from Pumpkin Seeds

Oil yield (%) = Extracted oil weight (g)/Weight of seeds used (g)

Oil present (%) = (0.92/2) = 46%

Table 3: Extracted Oil from Pumpkin Seeds through Soxhlet extraction

S. No.	Components	Result
1.	Oil content (per 2g)	0.92 g
2.	Color	Reddish-green

Conclusion

This study analyzed the nutrition composition and phytochemicals of pumpkin seeds (*Cucurbita spp*.) and watermelon seeds (*Citrullus lanatus*) from the Cucurbitaceae family to assess their viability as functional food sources. The findings indicated that both types of Seeds consists of vital nutrients, such as proteins, fats, fibre, and carbohydrates, along with considerable levels of minerals and moisture content. Results showed that both seeds are nutritious. Watermelon seeds contained more fibre (5.1%) than pumpkin seeds (1. 61% fibre) and less ash (3% ash) than pumpkin seeds (7%), important for digestion and mineral content. Fat content was also significant, with Watermelon seeds at 51.5% and pumpkin seeds at 46%. Pumpkin seeds had more protein (30%) as compared to watermelon seeds (20.64%). Both seeds have balanced carbohydrates (9.4% for pumpkin seeds and 10.4% for watermelon seeds).

Phytochemical evaluation confirmed the presence of mostly phytochemicals in both types of Seeds, highlighting their potential medicinal significance. These bioactive components are Recognized for possessing antioxidant, anti-inflammatory, and antimicrobial properties, thus Supporting the seeds' traditional applications in health and wellness.

Obtaining 0.92 grams of oil from just 2 grams of pumpkin seeds highlights their value as a rich source of plant-based oil.

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